

**Fermilab
FY2003 Self-assessment
Process Assessment Report
For
Technical Division**

28-Mar-2003

Division/Section performing assessment

Technical Division

Name of organization that owns assessed process

Technical Division, Engineering & Fabrication Department, Process Engineering Group

Organization Strategy

Knowledge of a devices fabrication & history is critical to the improvement and problem solving processes of manufactured/repared devices. The Traveler System documents the fabrication, testing, & repair history of a device's manufacture and repair.

Names of Personnel on Assessment team

Ted Beale

Name of process assessed

Accelerator Component Production QA Management & Documentation

Brief description of process to be assessed

The system is designed to define and document the sequence of fabrication, inspection, and testing during fabrication/assembly of all production runs and device repairs. Travelers serve as permanent records of the above including the required test results as defined in the document.

Are metrics associated with this process? If so, what are they?

There are no contractual or internal metrics for this process.

What are the names of the procedures associated with this process?

Quality Management Program (TD-2010)

Traveler System (TD-2050)

Are these procedures being followed? Are they current?

TD-2010 outlines the objectives, scope, and responsibilities of the traveler system. Critical steps in travelers require signoff by a responsible authority or authorized designee.

All of its requirements have been met.

Describe the methodology used to assess this process.

The methodology used to assess the process consisted of reviewing the available documentation and interviewing personnel that are responsible for creating and/or maintaining travelers.

Results of the assessment:

The overall results of the assessment are excellent. The system meets its objective and is well planned and executed. The use and application of travelers are thoroughly understood by all personnel involved the creation and maintenance of such. Although training isn't documented as required in the traveler documents, training and process knowledge are evident with all interviewed personnel. A recently implemented major improvement is the process of archiving travelers in a database after they are completed.

The two deficiencies noted have to do with the incomplete documentation of the Traveler System TD-2050, and the lack of documented training in the use of travelers and associated operating procedures (required for all travelers).

Travelers provide a means to define requirements, detail production methods, record inspection and test results, document device status, and serve as a permanent record of all work performed on a given device. There are large amounts of detailed information and test data contained within travelers about any given device that aid in problem solving and improvements. Creating and maintaining travelers is a large and necessary task.

All personnel performing steps in travelers are required to have documented training for travelers and associated operating procedures. Although those responsible for creating and maintaining travelers appear to be thoroughly trained and proficient in their use, the documentation requirement is not being adhered to.

Whenever a traveler is completed, all documents in the traveler are scanned into and archived in a database. The originals are sent to offsite storage and kept indefinitely. Those responsible for the process of archiving travelers into the database are well trained and appear proficient in the execution of such.

Archiving travelers in a database assures their efficient backup and retrieval, which can be an important factor in problem solving and improvements. The database provides easy access for Physicists, Engineers, etc., to any archived traveler.

When reviewing the traveler for EDWA004-1 it was discovered that a label on a magnet and in a traveler contained a typo (3.42 GPM should be 2.42 GPM). Corrective action has been completed on this item (see attachments).

Identified opportunities for improvement

TD-2050, and any supporting documents, should be updated.

Training in the use of travelers should be documented as required, or the requirement should be removed.

Schedule for implementation of improvements

TD-2050 is scheduled to be completed by end of FY2004.

New travelers for which we do not require training will not include the training statement. Travelers being revised will also have the statement removed.

Status of improvements from previous assessment

N/A

Attachments (supporting data, worksheets, reports, etc.)

The following attachments have been incorporated into this report:

Quality Management Program (TD-2010)

Traveler System (TD-2050)

Specification # 5520-TR-333661

10/22/2002 Rev. B

Magnet Serial No. EDWA 004-1

Readiness Review examples (EDWA)

Ring Test Specification (5520-ES-318052)



Fermi National Accelerator Laboratory

**Technical Division
Headquarters**

Quality Management Program

TD-2010

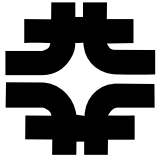
Version 2

Janice Blawie
Approved, TD Quality Assurance Officer

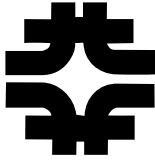
J. L. Lior
Approved, Technical Division Head

4/3/2001
Date

4/3/2001
Date



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Technical Division Quality Management Program

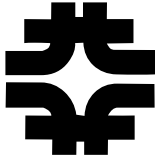
TD-2010

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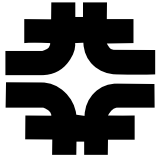
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Appendix A - Related Documents

Revision History

Version	Date	Section No.	Specifics
1	3/95	All	First version
2	02-Feb-2001	All	Updated to reflect organizational and policy/procedure changes

Controlled Distribution



Introduction

Background

The Technical Division was originally organized as the Technical Support Section in the early 1980s. It was at this time that Technical Services (consisting of the Conventional Magnet Facility and the Machine Shops) and the Energy Saver Section (consisting of the Superconducting Magnet Facility and the Magnet Test Facility) were combined to create the Technical Support Section. In the mid 1990s a reorganization of the laboratory occurred and the Technical Support Section became the "Technical Division". Although research was a part of the work as a section, the change to become a division made research a major portion of the mission of the organization.

The Technical Division maintains a diverse work force that has a very wide range of core competencies. In support of the R&D the division has experts in the fields of engineering, fabrication, tooling, machining/welding, procurement, calibration, testing, operations, maintenance, QA/QC and systems integration. The division also provides services in project management, project planning, resource management and scheduling. The Technical Division is heavily involved in the work of repairing and refurbishing existing devices, as well as design, fabrication and project management of a wide variety of HEP projects, including the next generation of particle accelerators, detectors, and astrophysics experiments.

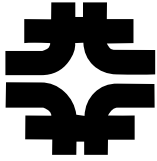
Quality Management Program

Due to the level of complexity of the work done in the Technical Division it was decided to implement a formal, documented program, which describes the practices used by the division to assure the quality of our work. Formal programs have proven to be effective in industry, if designed and implemented appropriately. *The Technical Division quality management program is applied to all the work done in the division.*

This document defines division policy and overall procedures for the organization. Although it covers the entire program, it is not meant to describe every detail of the quality program. Details regarding specific practices and procedures are maintained within each department.

The purpose of the program is to aid the division in assuring the quality of our work while not inhibiting the creativity of the people doing the work. By creating and maintaining our quality system, we are able to see and understand our organization as a *system*, not as separate groups working independently. This program is also a tool that is used to communicate and train people (both internal and external to the division) on how business is done in the division.

One of the goals of this type of program is to standardize routine processes, e.g. drawing approvals, while still being flexible and adaptable to improvements. Our desire is to have all division employees constantly challenge and push our activities to higher levels of performance, which enables us to continually innovate, improve, and learn. We strive to continually learn and improve in all that we do, which includes this program.



1.0 Program

This section describes the Technical Division quality system, and the functions and responsibilities of the departments and personnel.

The Technical Division's quality management program is based on the knowledge and expertise of the people that work in the division. The foundation for assuring quality is based on peer review. The practice of the division is to allow peers, i.e., colleagues who are actively engaged in the same profession, to be the arbiter of professional achievement. In other words, it is the job of the employees of the division to collectively assure quality. This process has a long history of success at Fermilab, and is a tested model in scientific research in general.

1.1 Policy

The policy of the Technical Division is to develop, document, and maintain its quality management program, so that the division can satisfy the needs of its customers.

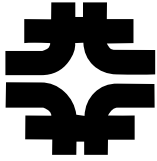
1.2 Mission

The Technical Division mission:

“The development, design, fabrication or procurement, and testing of accelerator and detector components.”

1.3 Objectives

- [1] To provide for fundamental research and development capability to support the high energy physics (HEP) programs.
- [2] To provide engineering and design support for the HEP programs.
- [3] To provide services of procurement, inspection, and storage of parts in support of the fabrication and testing programs.
- [4] To provide high quality fabrication and repair services for conventional iron and copper magnets, superconducting magnets, detector components, and other HEP components.
- [5] To provide a wide range of performance testing services for accelerator and detector components.



- [6] To provide machine shop and welding services in support of the fabrication and testing programs, and to make these services available to other laboratory organizations.
- [7] To apply and maintain an effective ES&H program that integrates sound ES&H practices into all division activities.
- [8] To apply and maintain a quality assurance program.

1.4 Division Organization

In order to accomplish the mission of the organization, the Technical Division is organized into projects and departments. Projects are organized by task and departments are organized by function. By and large, the way that the departments interact is through doing the work of the projects. Each department accomplishes the work done in the division, and it is done to fulfill the needs of the projects.

1.4.1 Projects

Projects are organized by task. The project manager for each project is responsible for the planning and execution of specific tasks, and for coordinating the work across departmental and administrative boundaries.

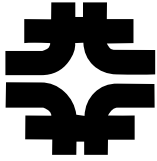
Specific projects, and their leaders, are defined in the division organization chart (see 1.4.3 below).

1.4.2 Departments

The departments are organized by function, and include:

- Computing and Information Systems
- Development & Test
- Engineering & Fabrication
- Machine Shop
- Material Control
- Support (Facility Management and ES&H)

The departments are responsible for personnel, infrastructure and administrative duties, and are organized to support the projects. Functional responsibilities for the departments are defined in section 1.5 of this document.



1.4.3 Organization Chart

The organizational structure of the division is defined graphically in an organization chart that is updated by the headquarters staff and approved by the Division Head on a monthly basis. The organization chart defines lines of responsibility for the employees of the division (contract employees may not be included in the organization chart). The chart also identifies personnel assigned to serve in key roles and/or special ES&H assignments. These include identification of such positions as Radiation Monitors, Emergency Wardens, ES&H Committee Members, Building Managers, et cetera.

Each Department Head is responsible for providing the headquarters staff with updates on a monthly basis regarding organizational changes resulting from restructuring.

Organizational changes resulting from personnel leaving the division or from new personnel starting work in the division are added to the organizational chart after the personnel paperwork has been processed by TD headquarters.

The Technical Division organization chart can be accessed from the Technical Division web site. See Appendix A for the most current location of the organization chart.

1.5 Functional Responsibilities - Departments

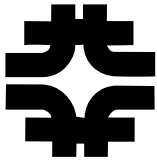
In addition to the following responsibilities, the departments may be requested to provide their specialized services and resources to approved special projects.

1.5.1 Headquarters

The Division HQ consists of the Division Head, other managers who assist the Division Head in the administration of the division, and appropriate support personnel. HQ is responsible for the overall administration and direction of the Technical Division, and is home for the project management of various projects (refer to the organization chart for current projects).

1.5.2 Support

The Support department provides the necessary resources to support the division with Environment, Safety, and Health services, as well as Facilities Management.



Environment, Safety and Health (ES&H)

The ES&H group, composed of ES&H professionals and support staff, provides the Division Head and other line managers with advice, analysis, and technical information regarding ES&H matters to enable them to carry out their responsibilities.

Laboratory policy documents describe the roles, responsibilities, and authorities of specified personnel who are members of the ES&H group, including the Senior Safety Officer (SSO) and the Radiation Safety Officer (RSO).

Facilities Management

The Director has assigned to the division buildings and grounds to be utilized in accomplishing the division's mission. The division is responsible for the operation and maintenance of these areas in conjunction with the Facilities Engineering Services Section (FESS). Large facility maintenance activities (>\$2K) are coordinated through TD Facilities Management.

1.5.3 Engineering and Fabrication

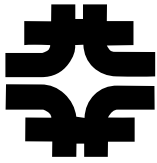
The Engineering and Fabrication department (EF) designs, manufactures, and repairs conventional iron and copper magnets, superconducting magnets, supporting hardware and tooling, detector components, and other related devices. The EF department also provides engineering, design, and technical services, which conform to appropriate safety and design standards, applicable state and national codes, and DOE contract requirements.

1.5.4 Machine Shop

The Machine Shop (MS) provides prototyping R&D and precisely machined and welded items to the division, and to other organizations laboratory-wide, in conformance with customer specifications. The MS also provides machine tool repair services to the division and makes these services available to other laboratory organizations.

1.5.5 Development and Test

The Development and Test department (DT) leads research and development projects for the division, particularly for superconducting magnets, prototype detector components and assemblies, and other advanced accelerator components. The DT department also provides a wide range of



performance testing services for conventional and cryogenic magnets and related devices, for both completed prototype and production devices.

1.5.6 Material Control

The Material Control department (MC) procures, inspects, and stores parts, tooling, and non-office supplies necessary for the operation of the division. It manages the warehousing of spare magnets and related devices. It provides metrology and QC services to the division and offers such services to other organizations of the laboratory. The MC department also provides expertise in developing processes for the fabrication of purchased components.

1.5.7 Computing and Information Systems

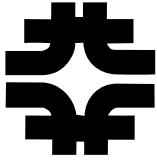
The Computing and Information Systems department (CIS) provides support to the division for computer needs and services. CIS is responsible for the set-up and ongoing maintenance for the information systems requirements of the Technical Division (which includes training of TD personnel), and works with the Computing Division as necessary to ensure compatibility with lab-wide systems. CIS is also responsible for the security of the TD network and servers.

1.6 Functional Responsibilities/Authorities - Personnel

1.6.1 General

Commitment to quality assurance is the responsibility of all individuals in the Technical Division. Management is responsible for giving attention to quality considerations in project and production planning, and for providing adequate resources to accomplish project goals. Every employee who manages, performs, or verifies work affecting quality has the accountability, authority, and organizational freedom to:

1. Identify and record quality/safety problems, or potential problems, and to stop work until the issue has been reviewed and addressed as necessary.
2. Initiate, recommend, or provide quality/safety improvements through appropriate channels.
3. Verify the implementation of solutions and corrective actions.
4. Control processing and delivery of product and services to ensure quality standards are met.



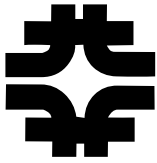
1.6.2 Job Descriptions

The laboratory personnel office maintains basic job descriptions for each job category. Because these job descriptions are very general and since job requirements tend to change often, more specific job requirements are defined between each employee and their supervisor. This can be accomplished through informal communications as well as through the annual performance review process.

1.7 DOE Orders

Appendix I of the Fermilab/DOE contract lists the DOE Orders that Fermilab has agreed to comply with. The Directorate maintains the most current list.

As DOE orders are to be applied to the entire laboratory organization, the Technical Division is responsible for understanding and implementing the requirements of the orders listed on the contract. This is accomplished through the TD quality system, ES&H program, and work practices.



2.0 Personnel Training and Qualification

This section describes the Technical Division's training program, as well as the division's policies on job qualifications.

2.1 Policy

The policy of the Technical Division is to hire personnel who possess the appropriate level of skill, experience, and academic qualifications to support the achievement of the division's mission; and to encourage their continual development through ongoing education, training, and expanded work experience.

All Technical Division personnel (including contract personnel) are to have the appropriate training and experience to ensure that they are capable of performing their assigned work to the appropriate level of safety, efficiency, and quality. In coordinating personnel training activities, training providers should be cognizant of the fact that the Technical Division scope of work involves the collaborative effort of personnel who have widely divergent levels of education, skills, and experience.

2.2 Responsibilities

2.2.1 Division Head Responsibilities

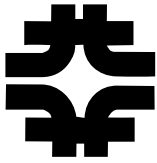
The Division Head provides the necessary resources to ensure that Technical Division personnel are appropriately trained and qualified for their jobs. The Division Head is responsible for personnel training and qualification for members of the headquarters staff, and for maintaining records of such training and qualifications.

The Division Head is responsible for the training of HQ staff and Department Heads so that they understand the requirements described in this program.

2.2.2 Department Head Responsibilities

Department Heads are responsible for personnel training and qualifications for their scope of work or activities, and for ensuring that the training is sufficient to enable their department to fulfill the stated objectives of the division. This training includes, at a minimum, basic skills, on-the-job training (OJT), the appropriate environmental, safety & health (ES&H) training that is defined in the Fermilab ES&H Manual, and the appropriate training on the division quality system and objectives.

Department Heads are also responsible for maintaining adequate records of the training (see section 2.8).



Refer to Appendix A for the most current location of the Fermilab ES&H Manual.

2.2.3 Line Management Responsibilities

Line management is required to be familiar with Laboratory policy on ES&H responsibilities as set forth in the Fermilab ES&H Manual.

Line management is responsible for ensuring that personnel training and qualification requirements are met for the assigned scope of work and activities. This includes Technical Division personnel and those personnel from outside the division who are under the direct supervision of line management.

2.3 Personnel Specific Positions (Job Openings)

Qualifications for specific job positions (job openings) are spelled out in personnel requisitions to ensure that only qualified candidates are considered for available positions. These personnel requisitions require a level of detail listing specific qualifications, required experience/skills, formal education, or any other job related requirement, and must be consistent with Fermilab Employment (personnel) requisition requirements, policies, and practices.

2.4 Education Qualifications

The education that is required for obtaining a university/college degree (or other professional certification) constitutes qualification for working within the discipline in which the degree was granted. Equivalent work experience and technical activity in a related discipline may also constitute acceptable qualifications.

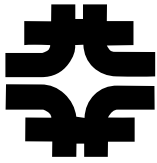
2.5 Individual Training Needs Assessment (ITNA)

To ensure that training needs are maintained at an appropriate level, a training needs assessment is required for each employee on an annual basis or whenever a change in job assignment or job hazards occurs.

The annual training needs assessment is conducted during the performance review process. It includes a review of employee training needs with respect to the work the employee is expected to perform or hazards that the employee would be exposed to in the normal performance of the assigned job.

2.6 Training Plan

An output of the performance review is a plan to implement the training needs of each employee within the division. Some training needs may be coordinated



through the headquarters office so that training can be provided division-wide (e.g. ES&H training). On-the-job training is coordinated through the Department Head and area supervision.

2.7 Specific Job Related Training

For work that does not require an accredited university/college degree or other professional certification, implementing management is responsible for developing training that is appropriate to the complexity, hazard, and programmatic significance for their scope of work or activities.

When it is determined that an employee needs specific job related training in order to effectively and efficiently carry out duties that are assigned, training will be made available to the employee. Where possible, in-house training will be provided to ensure that an appropriate level of skills, knowledge, expertise, and experience are available to accomplish the stated mission and objectives. Training may come from several sources such as mentoring, or as provided by physicists, engineers, supervisors, lead personnel, consulting firms, quality assurance personnel, Environment Safety & Health (ES&H) personnel, approved formal organizational training agents, or other sources. When in-house training is not practical or adequate, outside sources will be used to provide training.

2.8 Training Records

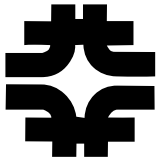
2.8.1 The TRAIN database is the official record for all ES&H training. ES&H training is recorded in the TRAIN database by ES&H personnel.

2.8.2 Records of on-the-job training (not related to ES&H) are maintained at the department or group level. The responsible group determines the method of record keeping, such as TRAIN. The method must allow for easy retrieval and review of the records.

These records may be limited to recording when the training was complete on the Performance Review form. It is not a requirement to maintain these records "real-time". It is sufficient to update the training records for the previous year during the performance review.

2.8.3 Records of training from attending formal courses are maintained by the individual taking the training. A note should be made on the performance review form that the training took place, but the individual maintains the official certificate.

2.8.4 Individuals who have been operating a piece of equipment for more than one year are considered to be "grand-fathered", and as such a record stating that they are trained does not need to be maintained.



3.0 Quality Improvement

This section describes the methods used by the Division to continually improve.

3.1 Policy

The policy of the Technical Division is to continually improve in all areas and activities for which it is responsible.

3.2 Reporting Deficiencies

All levels of personnel in the Technical Division are responsible for quality and are encouraged to promptly report conditions adverse to quality such as deviations, deficiencies, failures, defective items or processes, personnel safety concerns, and non-conformances to the appropriate level of management for corrective action. Employees closest to the daily operation or activity, i.e. line workers and line supervision, are in the best position to understand and report nonconforming conditions and are asked to participate in quality improvements to meet the needs and objectives of the division. A strong emphasis is also placed on fostering a "no-fault" attitude toward the person making the report. Division management believes that improvements will not take place if we "shoot the messenger", and making mistakes in the process of learning new things helps us to accept new ideas and improve.

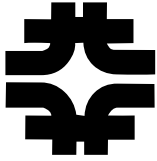
3.3 Suggesting Quality Improvements

Improvement not only occurs when we identify and correct problems, but also by adding controls to prevent problems from occurring in the first place. Every employee in the division has the authority and responsibility to think creatively about *preventing* problems from occurring, and to voice these ideas to supervision/management. It is supervision/management's responsibility and obligation to listen to these ideas, and to appropriately act on them with the employees. In this effort it is very important that we think as a system, i.e. changes we make can have negative impacts on other groups. A change that makes a local process safer or easier may add work to another process in another group. It is important to pay attention to the entire system when making "improvements".

3.4 Performance Analysis

3.4.1 Supplier Performance

Supplier performance problems are identified and reported through the mechanism of Quality Control Reports (QCRs), generated by the Material Control Department's Quality Control group for items such as incoming



parts and assemblies. These reports are reviewed and approved by the responsible authority/physicist (or designee) of the area or activity in which they will be used and by the Material Control Department Head (or designee). The review covers problems that may have significant programmatic effect or risk factors affecting cost, schedule, ES&H (personnel safety), or configuration. The appropriate disposition is given, i.e. scrap, return to vendor for replacement, rework at vendor, rework in house, or use as is. These reports are reviewed for supplier performance problems or trends and are used as a basis for cause analysis and necessary corrective action.

3.4.2 Work Process Performance

Discrepancy Reports have been developed and implemented to document problems such as deviations, defects in materials or processes, failures, malfunctions, and/or non-conforming conditions during fabrication, assembly or testing.

The responsible authority of the activity or area of occurrence reviews these discrepancy reports for technical evaluation, cause determination, disposition (corrective action), and preventive action recommendation. The appropriate personnel implement the corrective and preventive actions.

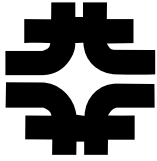
Process Engineering performs a review of these reports to ensure that reports are completed properly and that preventive action is adequate; the QA Manager may also recommend follow up corrective/preventive action or verification/validation as required. These discrepancy reports are used as a basis for trends, cause analysis, and/or lessons learned.

3.5 Design Reviews

At the conclusion of each design phase of a project a formal, documented, systematic, internal design review is conducted to ensure that the final design and supporting data will meet design code requirements and standards. The design review should identify and anticipate problem areas, inadequacies, initiate corrective action, and include representatives of all functions affecting quality as appropriate to the phase being reviewed. These formal design reviews are used as a basis of assessing design reliability, ES&H, safety issues, quality problems, design improvement, and design practicality.

3.6 Management Assessments

Management assessments are conducted following procedures established in the TD Self-Assessment Program. These audits cover environment, safety & health as well as quality assurance requirements. Results from these activities are used as a basis



for cause analysis or trending and the basis for continuous quality improvement from lessons learned.

3.7 Performance Review

The Laboratory Services Section requires annual performance reviews for all employees who have at least six months' service with the laboratory. The performance review allows management to assess each employee's effectiveness, to discuss recommendations for improvement as appropriate, and to jointly establish future performance goals and training.

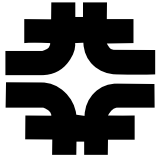
3.8 Individual Training Needs Assessment

To ensure that training needs are maintained at an appropriate level, a training needs assessment is required for each employee on an annual basis or whenever a change in job assignment or job hazards occurs. These training assessments are intended to promote continuous quality improvement by ensuring that the division's work force remains adequately trained and qualified. Section 2 of this document describes the division's training program.

3.9 Grassroots Safety Committees

Each department in the Technical Division has an employee grassroots safety committee. The primary purpose of these committees is to provide a forum for non-supervisory employees to identify and discuss unsafe conditions and practices in their workplace. These ideas for improvements are appropriately documented and sent to departmental management for assessment and action. This process has proven to be a very effective mechanism to help the division improve.

A "Guidance Document" was issued on 5/13/1999 that describes in more detail the overall process. Refer to Appendix A for the most current location of this memo.



4.0 Documents and Records

This section describes the methods used by the division to control the documents and records that are part of the quality system.

4.1 Policy

The policy of the Technical Division is to maintain adequate documentation and records to ensure quality requirements are met, while recognizing the objective of minimizing paperwork and overhead cost.

4.2 Definitions

Controlled document - any written or recorded information (other than data and records) that:

- is subject to change; and
- effects the quality of a product/service if the most current issue is not used.

A controlled document:

- Is approved for use by an authorized approver;
- Has a traceable revision history; and
- Has a controlled distribution.

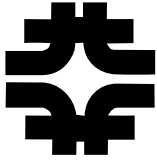
Quality Record - The certificates, forms, worksheets, tables, documents, orders, charts, memos, meeting minutes, and other records completed or generated throughout normal business operation. These records demonstrate conformance to specified requirements and effective operation of the quality system.

Readily Retrievable - Stored in a location and filed/indexed in a manner that allows the record to be obtained within one working day, or less, of moment of request for the record.

4.3 Responsibilities

4.3.1 Headquarters

TD Headquarters is responsible for maintaining documents and records related to the management of the Technical Division. These include such documents as division personnel files, hard-copies of ES&H self-assessment records, hard-copies of Significant and Reportable Occurrences (formerly 5000.3B reports), as well as information on budget, signature authority, security, and foreign travel.



4.3.2 Department Heads & Departments

Each Department Head is responsible for defining roles and responsibilities within their organization for the release, revision, and distribution of all documents and records at a level commensurate with the scale, cost, complexity, hazards, and programmatic significance of the work being documented.

Each department is responsible for documents and records associated with their activities, and shall define and document a records management system for their scope of work.

4.3.3 Quality Assurance Manager

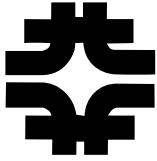
The QA Manager is responsible for assisting the division with the creation and maintenance of its quality system documentation.

4.3.4 Line Management

Line management is responsible for creating and maintaining the documents and records that describe products, services, equipment, software, procedures, and essential transactions at a level commensurate with the scale, cost, complexity, hazards, and programmatic significance of the work being done.

4.4 Document Control

- [1] Controlled documents are developed to ensure that complex work or hazardous conditions have the necessary controls to achieve personnel safety and to fulfill the Fermilab and Technical Division mission.
- [2] Controlled documents are reviewed, approved, and released by authorized personnel before they are distributed to and used at the location where the prescribed activity is performed.
- [3] Unless otherwise stated in specific procedures, authorized personnel may make hand-written changes to controlled documents as a *temporary change* only. The altered document should go through revision control as soon as is practical.
- [4] The distribution of controlled documents is managed such that a distribution list is maintained by the issuing organization to ensure that all issued documents contain the most current information. Every effort is made to minimize hard-copy distribution, and instead provide access via the computer network.



The following represents a listing of the types of documents defined as controlled documents for the Technical Division:

- [1] TD Policies and Procedures Manual (this includes the division quality program and its related documents)
- [2] Departmental and project quality programs/plans
- [3] Departmental procedures, work instructions, and specifications
- [4] CAD drawings

4.5 Records Management

The proper maintenance of records is important for the successful operation of the division. Records management begins with the creation of records. The creation of the appropriate records by the appropriate people is critical for understanding what we did in the past, as well as for figuring out where we stand today. *We must view the work of maintaining records as important as the work for which the record is about.*

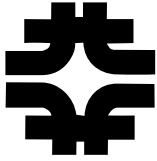
Records can normally be categorized as either administrative or technical. The main focus of Technical Division records management is on the technical records. The general policy of the division is to maintain technical records of a device for as long as the device is in service or has a possibility of being placed into service.

Records can come in two formats, hardcopy and electronic, and our records management program must be able to handle both types. Defining how we handle paper records is, in many ways, simpler than defining how we handle electronic records. Electronic records have the added complexity of platform and software dependence, which over time can cause some records to be irretrievable. In choosing an electronic records management system future migration needs must be considered. As platforms become obsolete critical data must be migrated to current systems.

Retention and accessibility of records can generally be described in the following ways:

- Records are retained in the immediate work area. Most people have access to them;
- Records are retained onsite, but not in the immediate work area. Fewer people have access to them;
- Records are retained in offsite storage. Minimal access is provided.

It should be noted that the main offsite storage is only for paper records, but that retention and accessibility issues can be applied to both paper and electronic records.

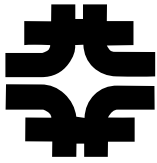


Due to the fact that the content and format of records vary greatly from department to department and project to project, each department or project is responsible for defining and documenting a records management system for their scope of work. Each system should take into account the following guidelines:

- The "major" record types should be defined, i.e. the ones critical to the mission of the department or project;
- The format(s) for each record type should be defined. Electronic records should include the appropriate technical details such as platform and software. For records that are in both paper and electronic forms, the primary form should be defined;
- A responsible authority for each record should be defined. Job titles or group names are most appropriate;
- The storage location for each record type should be defined. Records should be stored in a way that they are readily retrievable and stored in an environment that protects the records from damage, deterioration, or loss (archived records are not subject to the "readily retrievable" requirement);
- Retention and accessibility practices for each record type should be defined.

Appendix A contains references to various records management tools that are currently in use in the division.

The Technical Division's practice is to follow the Fermilab Records Management Program either when asked, or when necessary to move records to or from the offsite storage (i.e. archiving). Refer to Appendix A for the most current location of this program.



5.0 Work Processes

This section describes the methods used by the division to assure the quality of the processes used to conduct the business of the Technical Division.

The Technical Division organization practice is such that work processes occur in the departments and are defined in the department. The sections below provide an overview of each topic.

The central tool used by the division to control work processes is the "traveler". As a tool the traveler serves many functions, and these functions are described in the sections below.

5.1 Policy

The policy of the Technical Division is that work processes be well thought out, appropriately documented and reviewed, and that they be carried out by competent and effective workers.

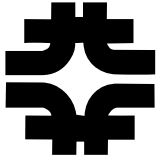
5.2 Hazard Analysis

Each Department Head is responsible for developing the means for analyzing work processes to determine if the work is sufficiently complex or hazardous to be performed to written procedures (see FESHM 2060 "Hazard Analysis for Fermilab Employees" for more details on hazard analysis). The Department Head is also responsible for developing a methodology for the preparation, review, and approval of procedures which is commensurate with the complexity, hazard potential, and ES&H impact.

5.3 Production Process Control

The EF Department Head, in conjunction with Project Managers, is responsible for ensuring that production processes are carried out under controlled conditions. When planning the production processes, the following are considered:

- All applicable government and laboratory safety and environmental regulations/policies.
- Use of travelers (or other such work instructions) to document the methods of production. These should be used when the absence of such procedures could be adverse to quality.
- Defining suitable equipment and work environment to ensure quality.
- Defining and conducting suitable maintenance of equipment to ensure continuing process capability.
- Defining the criteria for workmanship in the clearest practical manner. Examples of this are work instructions that document tolerances for process



parameters, samples or pictures of "quality" product, samples or pictures of poor quality or failure modes to look for.

- Level of education and experience required for production operators.
- Training needs for production operators

5.4 Travelers

A system of travelers is used to define the sequence of fabrication, inspection, and testing to be performed as appropriate for the division's scope of work.

Witness/Hold points are designated in travelers at a turning point or important juncture of the fabrication. Travelers provide for sign-off by qualified personnel and are dated at the completion of each fabrication sequence, welding operation, and inspection/test procedure by designated inspection/test personnel, fabrication personnel, or welding personnel to assure completion, date completed, and sequence of required operations.

The Process Engineering Group within the Engineering & Fabrication Department is responsible for the implementation and maintenance the traveler system.

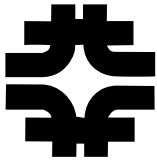
While travelers are used for all major production runs, and most "onesy-twosy" repairs, travelers may not be used in all situations. For example, it is recommended that travelers are used during the research/prototype phase of a project, but they are not a requirement. The Project Manager (or appropriate designate) decides whether or not to use travelers during the research/prototype phase. *However, once a product is approved to production, a traveler must be used. This means that it is very important that project planning includes the allocation of the proper resources to implement and maintain travelers for production.*

In the event that travelers are not used for the fabrication or rework/repair of a production device, it is still a requirement to maintain adequate as-built records. However, completing these records *after* the device has been built can lead to incomplete or incorrect information, and so *these records should be created as work is performed on the device.*

5.5 Identification, Traceability, and Test Status

All finished components are identifiable with names and serial numbers that are located on the unit and it's accompanying traveler(s). Serial numbers are marked on the unit according to a project specific serial number specification.

Sub-assemblies are identified appropriately. The method of identification depends on the sub-assembly and the scope of the label. Some possible identification methods include:



- A stamp or label containing pertinent information is placed on the device;
- A tag containing pertinent information is affixed to the device;
- Serial numbers may be assigned if the device is sufficiently complex (the use of a traveler to fabricate a sub-assembly usually means that the sub-assembly is assigned a serial number);
- Sometimes a sub-assembly will have no physical label, in which case we rely on people, and the corresponding drawings, to identify the parts.

The lot/batch/serial numbers of the parts going into the unit are recorded on the traveler, and so it is the traveler that is the main document used for traceability.

While it is being fabricated, the test status of the unit is identifiable using the accompanying traveler, i.e. the traveler will show how far along the unit is in the assembly and test process, as well as the results of the QC checks. When the unit is completely assembled, it is tagged showing the test status.

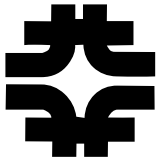
5.6 Control of Non-conforming Product

Most fabrication-related nonconformances are due to either a test result being out of specification or a process not working as was planned. At the point of a discrepancy or nonconformance the first-hand observer initiates a Discrepancy Report using the Discrepancy Report instructions as a guide. The DR is routed to Process Engineering personnel, and to the Project Engineer. The Project Engineer analyzes the data and disposes the item. If the item requires reworking then instructions for the rework are usually written in the DR. If the rework is sufficiently complex then a special rework traveler may be issued and used. After rework is completed the item is retested against the specification, and is dispositioned accordingly.

5.7 Materials Storage

In the Technical Division the Material Control Department is responsible for the storage of most work process equipment, materials, completed magnets, and other accelerator and detector components. The Material Control Department Head is responsible for establishing, documenting, communicating, and carrying out practices and procedures that ensure that items are stored and maintained to prevent damage, loss, or deterioration.

Other departments and groups within the division maintain small inventories. The group maintaining the inventories is responsible for ensuring that items are stored and maintained to prevent damage, loss, or deterioration.



5.8 Maintenance

Properly functioning equipment is critical to the success of the Technical Division. There are certain pieces of equipment for which there are specific preventive maintenance activities (e.g. oiling of motors, safety inspections, or third party maintenance contracts), but by in large most equipment used within the division is run-to-degradation. The success of this methodology relies on the continuous monitoring of equipment, systems, and operations. The goal is to catch problems early, so that a small problem can be fixed before it turns into a large and expensive problem. The operators of the equipment are in the best position to be able to identify problems at the earliest stages, e.g. hearing "funny" sounds or seeing more oil spilling than usual.

Each department maintains a list of all equipment owned by the department (referred to as a "Master Equipment List"). This list, or other such documentation, should define the planned maintenance activities, as appropriate. Part of the work to create and maintain the master equipment list should be to identify the critical parts for which the department should maintain adequate spares. The decision to maintain spares is made by comparing the risks involved if the parts had to be ordered each time to the cost of keeping the spares in inventory, i.e. a cost-benefit analysis.

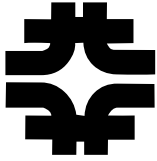
5.9 Readiness Reviews

Readiness reviews are conducted on certain activities to ensure that the proposed activity has been adequately planned and work prerequisites satisfied. The decision to require readiness reviews is principally based on the scope and risk of the project; i.e. a "large" project that is considered to have a high risk will require a formal review, while an activity that is considered to have a low risk may not require a review. For activities requiring a review, an individual is identified as the principal manager of the activity and is referred to here as the Project Manager.

The scale, complexity, number, and timing of readiness reviews is commensurate with the scope of the proposed activity and is determined by the Project Manager in conjunction with the Division Head. For Plant Projects, provisions and requirements for readiness reviews are addressed in the project's Conceptual Design Report, Technical Design Report or Project Management Plan, whichever is applicable.

Readiness reviews can be conducted as independent or dependent reviews. Dependent reviews are conducted internally to ensure that a specific group is ready to begin an upcoming activity (e.g. E&F internally reviewing their ability to begin working on a magnet). Independent reviews are described in the following paragraph.

Independent readiness reviews are coordinated by the Project Manager and are attended by qualified individuals or groups other than those associated directly with the planned activity to ensure an independent review is conducted (note: the term



"attended" does not necessitate a physical meeting; the format can be a telephone/video conference, or other such remote conferencing). Results from the review are used as the basis for assessing whether the activity planning has been accomplished in a complete and thorough manner and that issues such as resource requirements, personnel qualifications, ES&H matters, acceptance criteria, and quality control and assurance measures have been adequately considered and addressed. A written summary of the readiness review, including comments, concerns, and recommendations, should be provided to the Division Head and others as appropriate. The Project Manager is responsible for addressing issues arising from the readiness review and for providing adequate follow-up.

5.10 Device Data Management

A major portion of the work done in the division is the fabrication and repair of magnets used in the accelerator. Due to the volume of devices passing through the division, along with the change in division personnel, there is a need to document the work done on each device. The "device data management" system aids the division in tracking the status of every device, as well as to maintain at least a portion of our "institutional memory".

The departments that work directly on the devices, i.e. Material Control, Development & Test, and Engineering & Fabrication, use the device data management system. As work is done to the device a log is entered into the system, and its status is updated as necessary (e.g. recording that the measurement of the device has been completed in IB1 and that the appropriate authority has classified the device as "ready to use").

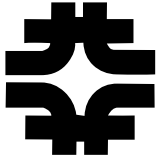
Further details about the system are found in the document *Device Data Management System TD-2030*.

5.11 Infrastructure

The quality of the infrastructure used by the division to fabricate and measure devices has a direct impact on the quality of the devices themselves. The proper design, fabrication and maintenance of our infrastructure is critical to the successful fulfillment of our mission. The same principles that are applied to ensuring the quality of the devices are applied to the infrastructure used to fabricate and measure the devices. It is for this reason that the scope of the quality system includes all infrastructure.

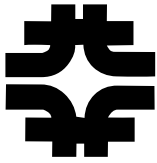
Infrastructure is typically used for either magnet fabrication (e.g. tooling) or magnet measurement (e.g. cryogenic, power, data acquisition and control systems).

Tooling is the work of the Engineering & Fabrication department and is typically managed with the same methodology as magnets, with the exception that travelers



are not used to fabricate tooling. Tooling is also part of the maintenance program (see section 5.8)

Measurement infrastructure is the work of the Development & Test department. Quality is ensured primarily through adequate design planning. Care is taken to ensure that systems are standardized as much as possible, as well as flexible enough to be able to measure various devices, as appropriate (i.e. multiple configurations). Configurations must be adequately documented so as to allow for easy setup the next time the configuration is used. The proper methodologies in fabrication, commissioning, operation and maintenance (see section 5.8) are also important for ensuring quality.



6.0 Design

This section describes the methods used by the division to assure the design quality of devices designed by the Technical Division.

The term "device" is used in this section to mean anything that is designed in the Technical Division. This includes all accelerator and detector related devices, tooling, cryogenic and power systems, as well as data acquisition and control systems.

6.1 Policy

The policy of the Technical Division is to ensure that designs perform as intended while minimizing cost. This is accomplished by having competent people incorporate sound engineering and scientific principles and appropriate technical standards into designs.

6.2 Requirements and Responsibilities

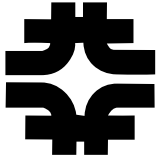
6.2.1 Introduction

Within the division, procedures and practices are established to ensure that sound engineering principles and appropriate standards are incorporated into all design work. These procedures describe how design and reliability requirements are established, as well as the translation of these requirements into design outputs such as specifications, drawings, procedures, and instructions. Design changes are effected as required to improve the quality, efficiency, or performance of a design and are subject to approval by the original design individual or organization or a qualified alternate.

It is the responsibility of the Heads of the Engineering & Fabrication (EF) and the Development & Test (DT) departments to establish sound engineering procedures, practices, design controls, and standards.

Project managers decide the degree of formality for the design process for their project, and so the overall design process varies by project. It typically follows the long-standing principles of the "scientific method", and can be described as follows:

1. State the issue - this is the work of defining the task(s) to be completed.
2. Form a Hypothesis - this is the work of defining the criteria that the device needs to meet, and then defining how the device is going to meet those criteria.
3. Observation and Experimentation - this is the work of building prototype devices (and components) and testing them against the hypothesis.



4. Interpretation of Data - this is the work of analyzing the data as compared to the hypothesis.
5. Draw a Conclusion - this is the work of either:
 - modifying the design of the device to more closely model the criteria; or
 - changing the hypothesis to match experimentation results; or
 - approving the design and moving on to the next phase.

This process is iterated until the desired performance of the device is achieved, or until it is concluded that the hypothesis does not work at this time.

In the world of quality assurance, this process is known as the "Plan-Do-Study-Act" process (first developed by Shewhart and then later it became known as the "Deming Wheel").

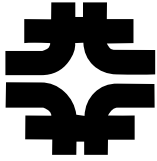


6.2.2 Design Input

Design input may come from many sources, which includes performance expectations, cost requirements, schedule constraints, material requirements, safety, and conceptual or research design reports and drawings. These inputs are defined by the "customer", which may be a Project Manager, TD research personnel, the Beam's Division, a project collaboration, or another HEP laboratory.

6.2.3 Design Process

The design process translates design inputs into design output documents. Design practices are communicated through proper education, training, and work experience, and may not be formally documented. A graded approach is used when designing components. Depending on the size, scope, and risks of the task, the process may range from being very informal (e.g. mostly verbal communication - "proof of concept" activities) to being very formal (e.g. mostly written communication). There is a wide range of complexity



and difficulty in design work, and it is this complexity which drives the formality and rigor of the design process.

Part of the design process includes the use of certain industry or laboratory specific standards or codes. These standards aid the designers in developing the most appropriate design. A list of some of the most frequently used standards is found in Appendix A.

6.2.4 Design Output

The main outputs of the design process are the drawings and specifications for the device. Other outputs include the information and documentation needed to support other processes such as procurement (e.g. parts lists and approved vendors), fabrication/assembly (e.g. travelers), inspection/testing (e.g. travelers), installation, and maintenance.

Each department is responsible for defining and documenting the methodology used for processing the initial release of drawings within their scope of work.

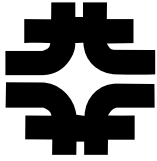
6.2.5 Design Verification

Prior to implementation, design verification is conducted at a level commensurate to the scope and complexity of a design to ensure that the design conforms to design requirements, adheres to applicable codes and standards, and minimizes hazards to operating personnel and the environment. Design verification may include design reviews, alternate calculations, and/or qualification testing under conditions simulating both operating and adverse conditions.

Design reviews are performed by qualified individuals or groups other than those who performed the original design to identify and anticipate problem areas and inadequacies, initiate corrective actions, and assess issues affecting safety and quality as appropriate to the design being reviewed. Results from this process are used as a basis for assessing design reliability, ES&H, safety issues, quality problems, design improvement, and design practicality.

6.2.6 Design Validation

Designs are validated through the testing of the complete prototype system (or subsystem) during and after assembly. It is the role of the Measurement and Test Facility (part of DT) to complete the validation testing. Data gathered by MTF is analyzed to determine whether or not the device will perform as required.



Again, a graded approach is used when validating designs. Depending on the size, scope, and risk of the task, the prototype build may not be tested at MTF.

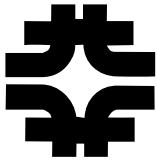
6.2.7 Design Changes

Depending on the scope of the project and the magnitude of the design change, design changes may be handled in various ways. If it is a small project and/or the design change does not have a major impact on the device or on other devices and systems, then design changes may be handled rather simply. This would entail following the established protocols for updating the drawings, parts lists and travelers (if travelers are being used).

If it is a large project and/or the design change has the potential to cause a major impact either on the device or on other devices and systems, then a "configuration review" is completed prior to the implementation of the change. A configuration review ensures that:

1. The change is necessary;
2. The consequences are acceptable;
3. The change has been properly documented; and
4. The plan for the implementation of the change into documents, hardware, and software is satisfactory.

Each department is responsible for defining and documenting the methodology used for processing changes to drawings within their scope of work.



7.0 Procurement

This section describes the methods used by the division to assure the quality of goods and services purchased by the Technical Division.

7.1 Policy

The policy of the Technical Division is to ensure that items and services provided by suppliers meet the requirements and expectations of the end-users at minimum cost.

7.2 Requirements and Responsibilities

7.2.1 Procurement

All procurement activities are performed in accordance with the *Fermilab Procurement Manual*, the *Fermilab ES&H Manual*, and the *TD Policy and Procedures Manual* (specifically TD-4100).

Short Orders, Procard, Stock Room and Petty Cash purchases

Any TD employee (with the appropriate authorization) may make purchases using short orders, procard, the FNAL stock room or petty cash. Individuals making purchases using these methods are responsible for following established procedures/protocols (including suspect/counterfeit items - see 7.2.5), and for maintaining the appropriate records of the transaction.

All other Technical Division Procurements

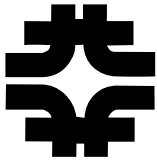
All other Technical Division procurements are routed through the Material Control Department for processing.

The Material Control Department is responsible for creating and maintaining the appropriate records for procurements to ensure that proper specifications, drawings, or other unique requirements are specified and supplied.

The Material Control Department is also responsible for tracking procurements and for ensuring that all necessary signatures and ES&H approvals are obtained.

Acquisitions for other Divisions/Sections

When the Material Control Department provides acquisition services to other divisions and sections of the laboratory, the division/section that is



asking for the service provides the appropriate budget codes and approvals to Material Control.

7.2.2 ES&H and NEPA Significance

All purchase requisitions, task order requisitions, and other procurements are reviewed for potential ES&H and NEPA significance as mandated by the Fermilab ES&H Manual chapters 5010 and 8060. Material Control personnel may perform an initial ES&H review for pre-qualified items, while TD ES&H personnel perform additional ES&H and/or NEPA reviews, as appropriate. ES&H and NEPA reviews are conducted as per processes defined in the TD Policy Manual, TD-4100.

7.2.3 Supplier Evaluation and Award

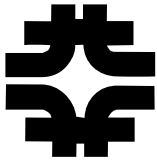
Contracts are awarded to suppliers based on their ability to meet subcontract requirements. These requirements are appropriately defined and documented, and include specific quality assurance requirements. Topics that are usually evaluated include, but are not limited to:

- Quality assurance measures Cost Work history
- Ability to meet all requirements Financial resources

Solicitations for bids or proposals can be structured in multiple ways. Except for sole sourcing, each method is designed to promote full and free competition, as well as to fulfill all the needs of the laboratory. On occasions where there is only one viable source, sole sourcing is available. A brief description of the various methods follows:

1. "Request for Quote" (RFQ) - this method is used when the materials or services to be purchased can be described in a clear and concise manner (i.e. with only drawings and/or specifications). The award is given to the lowest responsible bidder, usually decided by Purchasing.
2. "Request for Proposal" (RFP) - this method is used when a technical proposal is required for determination of the most responsive and responsible bidder for the stated requirements. The award decision is made by Purchasing as well as the appropriate technical personnel. The "formula" used to award the contract may or may not be determined prior to receiving bids.
3. "Sole Source" - this method is used when one source has exclusive capability to adequately perform the work within the time required and at reasonable prices.

Experience has proven, in general, the earlier that both the TD Material Control and the Business Services Procurement departments are involved in



supplier selections, the easier and more efficient this process will be. Both of these groups have expertise in identifying and selecting the best suppliers for doing work for the laboratory.

More details regarding supplier selection and the procurement process are documented in the Operating Procedures of the Fermilab Procurement Manual. See Appendix A for the most current location of the manual.

7.2.4 Supplier Development

Good communication between the TD and its suppliers is critical to ensuring the success and improvement of both groups. This is most commonly done through the use of Quality Control Reports (refer to section 3.3.1 for more details on QCR's).

Development work may include the training of the supplier on the use of travelers and other processing/fabrication tools and methods. This transfer of knowledge helps suppliers to improve their processes as well as assure that the requirements of the TD are met.

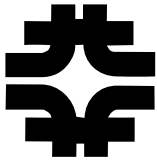
Part of the development of suppliers also includes proactive communication and involvement between the TD and the supplier. This type of development includes telephone monitoring as well as "vendor visits".

7.2.5 Suspect/Counterfeit Items

The Directorate and/or Business Services Section is responsible for identifying current Suspect/Counterfeit Items (S/CI) issues, and for communicating the appropriate information to the Technical Division. As appropriate, every individual who makes purchases for the Technical Division is responsible for understanding issues relating to S/CI, including:

- the parts/manufactures that are a concern; and
- the methods of preventing the procurement/use of S/CI

The most recent location for the DOE web site on suspect & counterfeit items can be found in Appendix A.



8.0 Inspection and Acceptance Testing

This section describes the methods used by the division to assure the quality of the fabrication and testing of high-energy physics components.

8.1 Policy

The policy of the Technical Division is to ensure that all items, components, and services meet the specified requirements. This is verified through the use of inspection and acceptance testing.

8.2 Requirements and Responsibilities

Department Heads are responsible for providing for inspection and acceptance testing equipment, methods and procedures as appropriate for their scope of work

Inspection and acceptance criteria are primarily defined in drawings and engineering specifications. Travelers state certain criteria, but these criteria are taken from the appropriate drawings and engineering specifications. Procurement documents may also be used to define certain inspection and acceptance criteria.

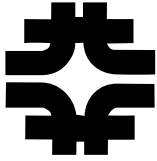
The equipment used for inspections and tests is required to be calibrated and maintained to ensure accuracy. Records of calibration are maintained by the group responsible for the calibration.

8.3 Receiving Inspection and Testing

The Technical Division Material Control Department is responsible for the verification of conformance of purchased items to procurement documents for non-standard items such as machined piece parts, components, and assemblies built to laboratory designs, and other unique purchased items. The Material Control Department is also responsible for the methods, procedures, and required documentation related to the inspection and testing. Verification is completed in the form of receiving inspection and/or in-plant surveillance (source inspections) which are performed by qualified personnel, test equipment, and methods. The Material Control Department is responsible for maintaining objective evidence of such qualifications and adequate records for all inspections and tests.

8.4 In-Process and Final Inspection and Testing

A system of travelers is used to define the sequence of fabrication, in-process and final inspection and testing to be performed on a device. The inspection and testing is completed using appropriately documented procedures and qualified personnel (refer to section 5.4 of this document for more information regarding the traveler system).



While travelers are used for all major production runs, and most "onesy-twosy" repairs, travelers may not be used in all situations. In the event that travelers are not used, it is still a requirement to develop adequate inspection and testing methods and to maintain records of all inspection and testing.

It should be noted that "final" inspection might also include performance measurements, such as taking magnet measurements at the Measurement and Test Facility of the Development and Test department or detector component measurements on a cosmic ray stand. The Project Manager is responsible for deciding when performance measurements are necessary. When performance measurements are required, the testing requirements must be appropriately defined, documented, and communicated to measurement personnel. Testing results must be appropriately documented and communicated back to the customer.

8.5 Measuring and Test Equipment Calibration

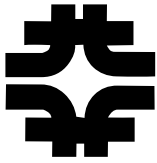
Calibration in the Technical Division can occur in two ways:

1. Equipment is tested with a reference, and the equipment settings may be adjusted to match the standard. After the calibration the equipment has a known accuracy.
2. Equipment is tested with a reference, and the equipment cannot be adjusted to match the reference. In this case, the calibration results are used to adjust the raw data from the equipment when it is used to measure product.

All equipment which effects product quality (or is used to make a decision which effects product quality) is calibrated at prescribed intervals, and is appropriately identified with its calibration status. In general, calibration reference standards are traceable to NIST or other national/international organizations. If no national standard exists, then the basis used for calibration is appropriately documented.

Department Heads are responsible for analyzing their work process measuring and test equipment to determine the appropriate calibration requirements. Department Heads are also responsible for developing an effective program for the necessary calibration activities.

The Material Control department provides calibration services for the calibration of mechanical instruments and equipment used by the division. And although Material Control performs the calibration service, and may recommend the frequency with which equipment should be inspected and recalibrated, the Department Head whose organization owns the equipment is responsible for ensuring the equipment is properly maintained and calibrated.



9.0 Quality Assessment

This section describes the methods used by Technical Division to assess the adequacy, implementation and effectiveness of the Technical Division's quality system.

Within the Technical Division there are three types of assessments: *management*, *worker* and *independent*.

9.1 Policy

The policy of the Technical Division is to regularly assess the division's effectiveness in meeting its objectives, goals, and compliance to orders and regulations. This is accomplished using the Technical Division Self-Assessment Program.

The TD Self-Assessment Program describes the formal management (and independent) assessment process for the division. Highlights of the program, as well as other assessment methods (more informal) that the TD uses are described in the section below.

9.2 Management Assessments

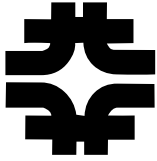
Management assessments are dependent internal assessments because the people, i.e. managers, who are doing the assessment have direct responsibility for the area being assessed. This type of assessment is very important for assuring that the entire division is working to assure the quality of our products.

9.2.1 Division Head Assessments

Each calendar quarter the Division Head conducts a meeting with a different Department Head and other representatives from the Division to assess specific areas of functional responsibility and performance objectives within that department. An agenda of topics to be reviewed is normally distributed prior to the meeting. Topics that are typically reviewed include: employee training status, self-assessment pending issues and findings status, ES&H policies or procedures to be implemented or discussed, schedule requirements, budget issues, administrative policy or procedural issues, quality issues, and training.

9.2.2 Department Head Assessments

Department Heads are responsible for the assessment of the activities within their scope of work and to provide first-hand assessment concerns to the Division Head for review, suggestions, recommendations, and a plan of appropriate corrective action. Department Heads periodically meet with their



crew chiefs, line supervisors, and lead personnel, either individually or as a group, to assess progress and performance objectives and to implement policy direction from the Division Head.

9.2.3 Line Supervisor Assessments

Line supervision is responsible for the daily operations of the division. Line supervision or lead personnel regularly interact with their personnel to assess the scope of their activities and performance objectives. These conversations provide for first-hand assessments and recommendations from line personnel to improve on existing procedures, policies, scope of work, and other line personnel concerns.

Suggestions and recommendations are presented to the appropriate levels of management for consideration or clarification and to enable management to take the appropriate necessary corrective action commensurate with the programmatic significance or importance of the problem.

9.3 Worker Assessments

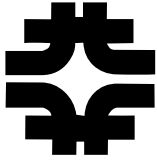
Worker assessments involve the worker routinely comparing the processes and products to defined expectations. Worker assessments are critical to the proper functioning of the division. As stated in section 3, employees closest to the daily operations are in the best position to understand deficiencies, provide feedback on them, and to make recommendations for improvement. The practice of analyzing a task before starting it aids the division in preventing problems.

Examples of methods to provide feedback include Discrepancy Reports (see 3.4.2), Traveler Revision Requests, Grassroots Safety Committees (see 3.9), and daily interaction with supervision (see 9.2.3).

9.4 Independent Assessments

Independent assessments are conducted by a person (or a group or people) who is not directly responsible for the area being assessed. These assessments can be conducted by people from within or from outside the Division. Examples of these are assessments performed by the QA Manager or SSO on departmental or project quality/ES&H programs, "OSHA" inspections by TD ES&H inspection teams, Tripartite assessments, or assessments conducted by the DOE on TD activities.

Independent assessments focus on *systems*, and use fact-based observations as a basis for drawing conclusions about the health of the organization's systems and reporting these conclusions in a way that can be used by line managers to initiate long-term improvement.

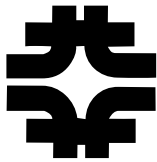


Technical Division assessments gather information from management systems on:

1. *Adequacy* - do the systems as they are designed have the potential to succeed?
2. *Implementation* - are the systems being implemented as designed?
3. *Effectiveness* - are the systems achieving their intended results?

Findings, concerns, and recommendations generated as a result of independent assessment activities are typically reported in writing to the person responsible for the area being assessed. Findings are also entered into the laboratory ES&H tracking database (ESHTRK - refer to Appendix A for the most current location) and are assigned to the appropriate person who is responsible for the corrective actions. Tracking of findings to closure occurs through the mechanism of the Quarterly Report to the Director describing self-assessment activities. In preparing the Division's report, Division line management reviews the status of all open ESHTRK findings.

More details of independent assessments are described in the TD Self-Assessment Program (SAP). Refer to Appendix A for the most current location of the Self-Assessment Program.



Section 1:

Technical Division Organization Chart

<http://www-td.fnal.gov/> ("Tech Division Info" tab)

Fermilab Policy Manual

<http://www.fnal.gov/directorate/documents.html> ("Fermilab Director's Policy Manual")

Fermilab ES&H Manual

http://www-esh.fnal.gov/home/esh_home_page.html ("Manuals and Procedures")

Appendix I of the DOE/Fermilab Prime Contract

Available in hard-copy from the Directorate (bobgrant@fnal.gov).

TD Policies and Procedures Manual

Hard-copy distributions in the headquarters library and the Senior Safety Officer. Documents are also being migrated to the TD home page <http://www-td.fnal.gov/> - click on the "Tech Division Info" tab.

Section 2:

Fermilab ES&H Manual

http://www-esh.fnal.gov/home/esh_home_page.html ("Manuals and Procedures")

Performance Review

<http://fnalpubs.fnal.gov/policyguide/art01set.html> (article 25)

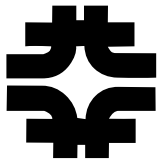
See also <http://fnalpubs.fnal.gov/lssection/2000review.html>, and replace the year with the current year.

TRAIN database

http://www-esh.fnal.gov/home/esh_home_page.html ("Training and TRAIN")

Grassroots Committee Guidance Document

Available in hard copy from division headquarters.



Section 3:

Technical Division Self-Assessment Program TD-2020

Hard-copy distribution in TD Headquarters. Electronic version maintained in the "OnBase" document management system under "TD Quality Assurance",
URL <http://td-docs.fnal.gov/webdms/login.asp>.

Performance Review

<http://fnalpubs.fnal.gov/policyguide/art01set.html> (article 25)

See also <http://fnalpubs.fnal.gov/lssection/2000review.html>, and replace the year with the current year.

Section 4:

Fermilab Records Management Program

<http://www-bss.fnal.gov/RecordsManagement/handbook.html>

DOE Records Management

<http://www-it.hr.doe.gov/records/>

General Records Schedule 20 - Electronic Records

<http://andor.nara.gov/grs/grs20.htm>

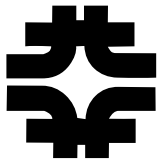
36 CFR Part 1234 - NARA Electronic Records Management

<http://www.access.gpo.gov/nara/cfr/cfr-table-search.html> (there are various search methods, choose one that suits your needs)

Technical Division records management tools:

OnBase[®] document/records management system

<http://tdserver1.fnal.gov/proeng/>



TD Technical Notes

Used to document, publish and organize results of work activities. Speak with [Sharon Spatafora](#) about the details of this system. Documents can be downloaded from <http://tdserver1.fnal.gov/tdlibrary/TD-Notes/>.

Fermilab Drawing Control System (DCS)

<http://www-cad.fnal.gov/groupinfo/dcs/dcsinformation.html>

Section 5:

Fermilab ES&H Manual

http://www-esh.fnal.gov/home/esh_home_page.html ("Manuals and Procedures")

Device Data Management System TD-2030

Hard-copy distribution in TD Headquarters. Electronic version maintained in the "OnBase" document management system under "TD Quality Assurance",
URL <http://td-docs.fnal.gov/webdms/login.asp>.

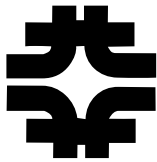
Section 6:

TD Technical Notes

All notes available from the TD network at \\tdserver1\project\Tdlbry\TD-Notes (web address <http://tdserver1.fnal.gov/tdlibrary/TD-Notes/>). Some notes available from the web in a searchable database at <http://tdpc84.fnal.gov/cgi-bin/docLib-prd/document.pl>.

FESHM chapters (all found in the Fermilab ES&H Manual):

- 2010 - Planning and Review of Accelerator Facilities and Their Operations*
- 5021 - Overhead Cranes, Hoists and Rigging*
- 5031 series - Pressure Vessels and Piping*
- 5032 series - Cryogenic Systems*
- 5033 - Vacuum Vessel Safety*
- 5034 - Pressure Vessel Testing*
- 5035 - Mechanical Refrigeration Systems*



National Codes (ASME codes available in hard-copy in EF Design & Drafting group and the laboratory library):

ASME Boiler and Pressure Vessel Code Section VIII

ANSI/ASME Y14.5M - Dimensioning and Tolerancing

ASME B30.20 - Below-the-Hook Lifting Devices

ASME B31.1-9 - Piping

National Electrical Codes Handbook (available in hard-copy in DT Instrumentation & Controls group and from the laboratory library)

ANSI/ISA-S5.1 - Instrumentation Symbols and Identification (available in hard-copy in DT Instrumentation & Controls group)

Procedure for the processing of ERs and ECOs - Specification #5500-ES-360000

Available in hard-copy from the Engineering and Fabrication department (the scope of this procedure is devices designed by EF).

Section 7:

Fermilab Procurement Manual

<http://www-bss.fnal.gov/Procurement/index.html>

Fermilab ES&H Manual

http://www-esh.fnal.gov/home/esh_home_page.html ("Manuals and Procedures")

TD Policies and Procedures Manual

Hard-copy distributions in the Headquarters library and the Senior Safety Officer.

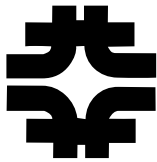
DOE Suspect & Counterfeit Items

<http://twilight.saic.com/qawg/> ("Alerts and Advisories")

Section 8:

National Institute of Standards and Technology (NIST)

<http://www.nist.gov/>



Section 9:

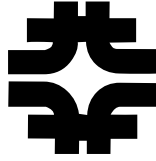
Technical Division Self-Assessment Program TD-2020

Hard-copy distribution in TD Headquarters. Electronic version maintained in the "OnBase" document management system under "TD Quality Assurance",

URL <http://td-docs.fnal.gov/webdms/login.asp>.

ESHTRK

http://www-esh.fnal.gov/home/esh_home_page.html ("Assessments and ESHTRK")



Fermi National Accelerator Laboratory

**Technical Division
Headquarters**

Traveler System

TD-2050

Version 1 - DRAFT

Approved, Quality Assurance Officer

Date

Approved, Engineering & Fabrication Head

Date

Approved, Technical Division Head

Date



Technical Division Traveler System

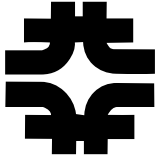
TD-2050

Date: 19-Nov-2001

Version: 3

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1.0	SYSTEM OBJECTIVE	3
2.0	SYSTEM SCOPE	3
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1.0 System Objective

The objective of the Traveler system is to define the sequence of fabrication, inspection and testing to be performed as appropriate for the division's scope of work.

2.0 System Scope

The system is used during fabrication/assembly for all production runs and device repairs, but is not a requirement during the research & development phase of a project. The Project Manager (or appropriate designate) decides whether or not to use the traveler system during the R&D phase of a project.

Although travelers are not required for R&D projects, it is highly recommended to utilize this process during the R&D phase of a project. Doing so will allow the division to systematically record, track and maintain the knowledge gained during R&D fabrication.

3.0 Definitions

3.1 *Responsible Authority or Authorized Designee*

The Responsible Authority is the person in charge of the area or activity of which the traveler pertains to. This person should have a detailed understanding of the process in question.

The Authorized Designee is authorized by the Responsible Authority to act on his/her behalf, in his/her absence or as an expert contact in specified areas or activities.

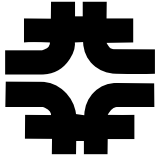
4.0 Responsibilities

4.1 *Process Engineering*

The Process Engineering Group, within the Engineering & Fabrication Department, is responsible for the implementation and maintenance of the traveler system. Process Engineering works with Production and Engineering in the development and maintenance of the travelers.

4.2 *Department Heads & Project Managers*

Department Heads & Project Managers are responsible for providing adequate resources to allow for adequate resources to implement, operate and maintain the traveler system. Travelers are part of how the division conducts business, and so appropriate resources must be allocated.



4.3 *Quality Assurance Officer*

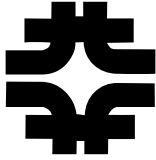
The Quality Assurance Officer is responsible for helping to develop and maintain the traveler system. The QA Officer is also responsible for coordinating the appropriate training on the system.

4.4 *Responsible Authority*

The Responsible Authority is responsible for reviewing and approving critical steps in the traveler. *It should be noted that the "Responsible Authority" does not have to be one person - there can be many Responsible Authorities for one traveler.*

5.0 System Specifics

5.1 *Descriptions*



Technical Division Traveler System

TD-2050

Date: 19-Nov-2001

Version: 3

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Revision History

Version	Date	Section No.	Specifics
1 - DRAFT	19-Nov-2001	All	First version

Controlled Distribution

Technical Division library



Fermi National Accelerator Laboratory
Batavia, IL 60510

BOOSTER 5.3 - 2 - 120
EDWA DIPOLE MAGNET
DIS-ASSEMBLY/RE-ASSEMBLY
with BEAM TUBE

FEB 13 2003

Reference Drawing(s):
Booster EDWA Dipole Final Assembly
ME-388191

Project:	<i>Booster</i>	Magnet/Device Series:	<i>EDWA</i>
Budget Code:	<i>FoF</i>	Project Code:	<i>0166</i>
Released by:	<i>Bob Jensen</i>	Date:	<i>10/25/02</i>
Date Closed:	<i>2/12/03</i>	Scan Pages:	<i>32</i>
Prepared by: B. Jensen			
Title	Signature	Date	
TD / E&F Process Engineering	<i>Bob Jensen</i> Bob Jensen / Designee	<i>10/22/02</i>	
TD / E&F Assembly	<i>Dan Smith</i> Dan Smith / Designee	<i>10/22/02</i>	
TD / E&F Project Engineer	<i>Sasha Makarov</i> Sasha Makarov / Designee	<i>10/22/02</i>	
TD / E&F Fabrication Manager	<i>John Carson</i> John Carson / Designee	<i>10/22/02</i>	

4-1
per Bob

Revision Page

Revision	Step No.	Revision Description	TRR No.	Date
None	N/A	Initial Release	N/A	4/10/02
A	7.3	Added Step from TR-333660. 'Weld the Manifold Holder Plate.....'	1477	8/22/02
	8.8	New step; Prime all areas of the magnet not previously painted with Paint Primer (MA-388153). Note: Do not prime the survey holes, ground lug hole, etc.		
	8.9	New step; Paint all primed areas of the magnet using Paint FINAL Blue (MA-351184). Note: Do not paint the survey holes, ground lug hole, etc.		
	8.10	Added Step from TR-333660. 'Wrap all leads.....'		
	8.11	New step; Verify the magnet is properly painted and stenciled.		
B	5.3	New. Indicate if Beam Tube is received with or without Locating Pins welded on tube.	1504	10/22/02
	5.4	New. If beam tube is received without positioning lugs pre-welded in place, position, mark, and weld the locating pins (MA-412028) (2 ea) onto the beam tube as per Beam Tube Assembly DWG (MD-412004).		
	5.0	Section 5.0 Re-arranged steps 5.14 to 5.21 to incorporate new parting plane measurements/tables and to increase final bolt torque to 350 ft/lbs.		

Ensure appropriate memos and specific instructions are placed with the traveler before issuing the sub traveler binder to production.

1.0 General Notes

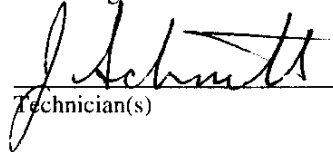
- 1.1 White (Lint Free) Gloves (Fermi stock 2250-1800) or Surgical Latex Gloves (Fermi stock 2250-2494) shall be worn by all personnel when handling all product parts after the parts have been prepared/cleaned.
- 1.2 All steps that require a sign-off shall include the Technician/Inspectors first initial and full last name.
- 1.3 No erasures or white out will be permitted to any documentation. All incorrectly entered data shall be corrected by placing a single line through the error, initial and date the error before adding the correct data.
- 1.4 All Discrepancy Reports issued shall be recorded in the left margin next to the applicable step.
- 1.5 All personnel performing steps in this traveler must have documented training for this traveler and associated operating procedures.
- 1.6 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step.
- 1.7 Cover the magnet assembly with green Herculite (Fermi stock 1740-0100) when not being serviced or assembled.
- 1.8 All Room Cure Epoxy to be applied at an ambient temperature of 65° F.

2.0 Parts Kit List

- 2.1 Not Parts Kit Required. See Traveler TR-333660.

3.0 Incoming Inspection

- 3.1 Visually inspect the magnet for damage. Inspection should include but not restricted to, the magnet cores, coil (return and lead) ends, electrical power flags and water manifold. ☒
- 3.2 Ensure all water manifold hardware, including ferrules, fitting/fitting nuts, etc., are present. ☒
- 3.3 Verify the EDWA Dipole Magnet has a 'MTF Measurements' sticker applied to the magnet. ☒

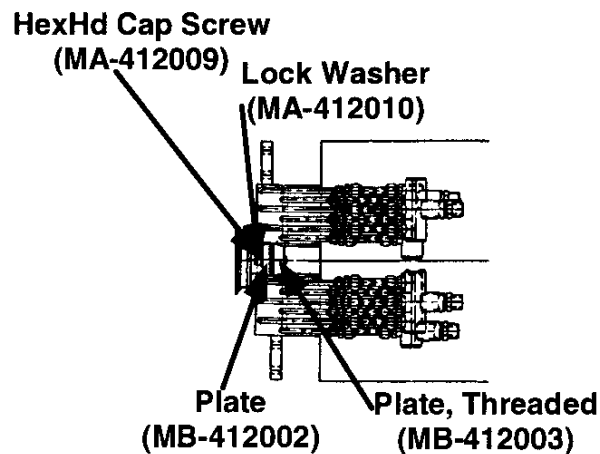


Technician(s)

11-18-02
Date

- 3.4 Remove from the Upper Coil Assembly Connecting Plate and Lower Coil Assembly Connecting Plate; Plate (MB-412002), Plate Threaded (MB-412003), Hex Socket Head Cap Screw (MA-41200) and Lock Washer (MA-412010). ☒

Note: All screws, lock washers, plate, and plate, threaded are to be saved for later re-installation.



3.5 Perform an electrical check of the Upper and Lower Coil and record results below.

Note: Insulate the Upper Coil Connecting Plate from the Lower Coil Connecting Plate using 0.005" kapton non-adhesive film before performing the Electrical Inspection.

Upper Coil	Equipment Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Coil Resistance	32-1005	14.1 to 17.1	14.97 mΩ	✓		
LS @ 1 KHz	84018	For Reference Only	941 μH	✓		
Q @ 1 KHz		For Reference Only	1.4			
LS @ 100 Hz		For Reference Only	2.46 mH	✓		
Q @ 100 Hz		For Reference Only	1.4			
100 V Ring				✓		
Hi Pot Coil to Core 1500 V	AR0503	< 5 μA	< 1 μA	✓		

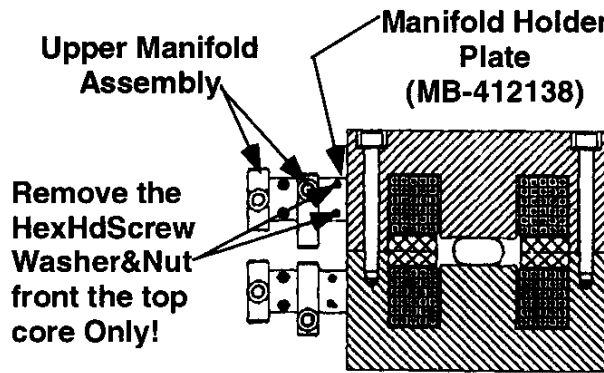
Lower Coil	Equipment Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Coil Resistance	32-1005	14.1 to 17.1	14.96 mΩ	✓		
LS @ 1 KHz	84018	For Reference Only	922 μH	✓		
Q @ 1 KHz		For Reference Only	1.3			
LS @ 100 Hz		For Reference Only	2.49 mH	✓		
Q @ 100 Hz		For Reference Only	1.4			
100 V Ring				✓		
Hi Pot Coil to Core 1500 V	AR0503	< 5 μA	< 1 μA	✓		

DW
Inspector

11/18/02
Date

4.0 Magnet Dis-AssemblyCompleted ☒

- 4.1 Remove the Hex Socket Head Cap Screws (MA-412007) (14 ea) with 1" Flat Washer (MA-412008) from the Upper Half Core Bolt Holes.



**EDWA Magnet
(Return End looking toward Lead End)**

- 4.2 Remove the Hex Hd screws, washes, & nuts holding the Upper Coil Manifold from the Manifold Holder Plate. This will allow the Upper Core to be removed without dis-assembling the Upper Coil Manifold Assembly.

☒

Note: The Lower Coil Assembly manifold will not be removed.

Bob Hill
Technician(s)

11/18/02
Date

- 4.3 Using the overhead crane and appropriate lifting equipment, remove the Upper Core Assembly (ME-388242). ☒
- 4.4 Remove the Polyurethane Pads (MA-412006) from the top of the Upper Coil Assembly. ☒

Note: Polyurethane Pads will be re-used during re-assembly of magnet.

- 4.5 Using the overhead crane and appropriate lifting equipment, remove the Upper Coil Assembly (ME-388193). ☒

Bob Hill
Technician(s)

11/18/02
Date

October 22, 2002

Rev. B

5.0 Magnet Re-Assembly with Beam Tube Assembly

- 5.1 Visually inspect the Beam Tube (MD-412004) for damage including dents and dings and attach the incoming leak check sticker below. ☒

Note: If beam tube is received with an incoming leak check sticker, perform a vacuum leak check and record results below.

PART NO.	DATE TIME	OPERATOR'S LAST NAME	SCALE UNITS BEFORE HELIUM PROBE	SCALE UNITS WHILE ENCLOSURE FLOODING	DETERMINATION OF MINIMUM DETECTABLE LEAK			
					MDS + ((Response - Bckgnd) + Leak Value) = MDL			
412004 EDWA BT w/ PINS		GDW	2241	2241	2	4045	2281	3.95/10.35/10
Inspector			Date					

- 5.2 Clean the Beam Tube Assembly (MD-412004) using Isopropyl Alcohol (Fermi stock 1920-0300). ☒

- 5.3 Beam Tube received with Locating Pins welded, proceed to Step 5.5. ☒

Beam Tube received without Locating Pins not welded, proceed to Step 5.4 ☒

- 5.4 If beam tube is received without positioning lugs pre-welded in place, position, mark, and weld the locating pins (MA-412028)(2 ea) onto the beam tube as per Beam Tube Assembly DWG MD-412004. ☒

Technician(s) J. Schmitt
Date 11-18-02

Welder A. in
Date 11/15/02

- 5.5 Install Beam Tube Assembly (MD-412004). Ensure the Locating Pins are properly installed into the pins holes in the Lower Half Core. ☒

Technician(s) J. Schmitt
Date 11-18-02

- X 5.6 Verify the Beam Tube is installed correctly and the locating pins are properly installed into the Lower Half Core. ☒

[Signature]
Lead Person

11-18-02
Date

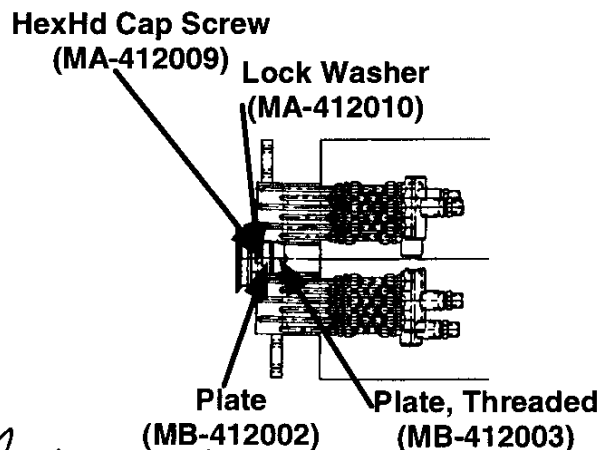
Completed ☒

- 5.7 Install one Upper Coil Assembly. Ensure Coil Assembly is centered longitudinally with respect to the Lower Half Core. Ensure Coil Serial Number matches Step 6.10 serial number

Note: During installation of the Upper Coil Assembly, ensure the Connecting Flags on the Upper Coil Lead End and Lower Coil Lead End are aligned properly and are not damaged.

- 5.8 Connect the Upper Coil Assembly Connecting Plate and Lower Coil Assembly Connecting Plate together with Plate (MB-412002), Plate Threaded (MB-412003), using Hex Socket Head Cap Screw (MA-41200) and Lock Washer (MA-412010).

Note: Do not tighten screws. This allows sliding of the coils during the Upper Half Core installation.



[Signature]
Technician(s)

11-18-02
Date

- 5.9 Install Polyurethane Pads (MA-412006) onto the top of the Upper Coil Assembly as per EDWA Final Assembly (ME-388191).

[Signature]
Technician(s)

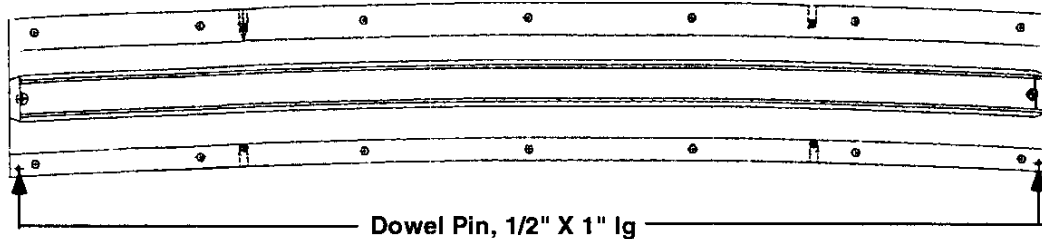
11/18/02
Date

- X 5.10 Verify Polyurethane Pads are correctly installed.

[Signature]
Lead Person

11-18-02
Date

- 5.11 Ensure Dowel Pin (MA-412012) (2 ea) are properly installed in the Lower Half Core as per EDWA Final Assembly Dwg (ME-388191).

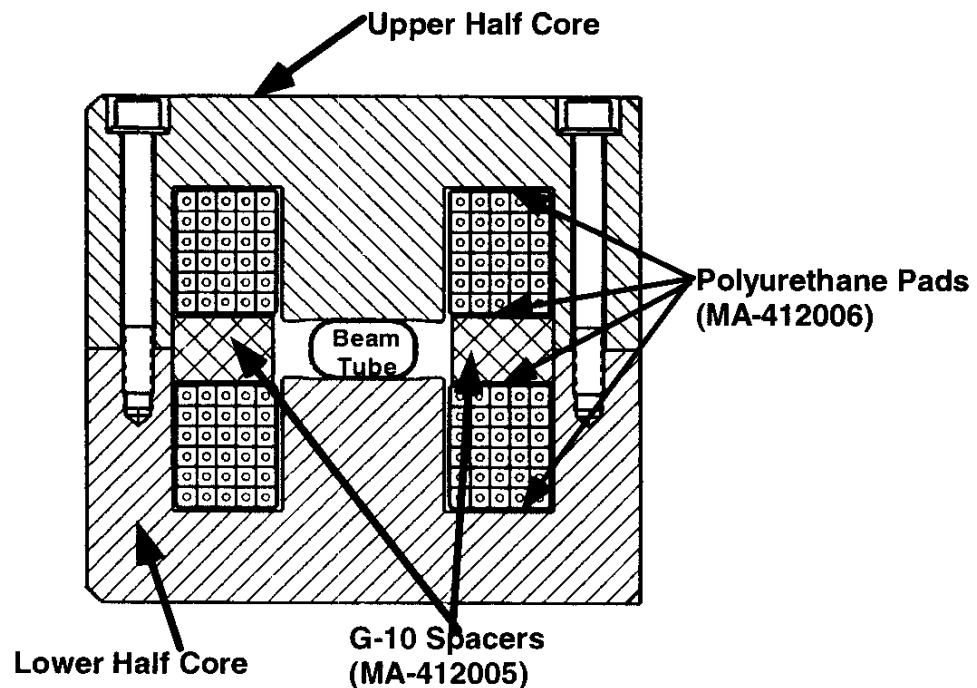


Rob Hill
Technician(s)

11/18/02
Date

- 5.12 Using the overhead crane and appropriate lifting equipment, position the Upper Core Assembly (ME-388242) onto the magnet assembly. Ensure Upper Half Core aligns with the Lower Half Core alignment dowel pins. ☒

Note: During installation of the Upper Core guide the Upper Half Core to prevent damage to the Upper Coil Assembly including Power Flags and Upper Coil Manifold Assembly.



Rob Hill
Technician(s)

11/18/02
Date

October 22, 2002

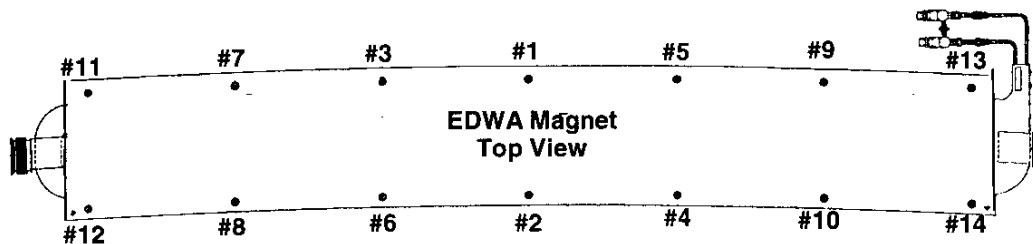
Rev. B

Completed ☒

- 5.13 Install Hex Socket Head Cap Screws (MA-412007) (14 ea) with 1" Flat Washer (MA-412008) into the Upper Half Core Bolt Holes.

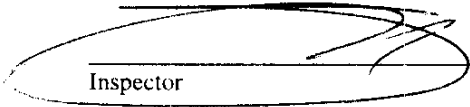
Bob Hill
Technician(s)

11/18/02
Date



- 5.14 With the cores in place, and bolts not tightened, measure and record the parting plane gap at 6" intervals starting at the lead end on both sides of the magnet.

Inches from the Lead End	Limit	Left Side	Right Side
0"	< 1 mil	.032"	.034"
6"	< 1 mil	.032"	.034"
12"	< 1 mil	.031"	.034"
18"	< 1 mil	.031"	.033"
24"	< 1 mil	.031"	.033"
30"	< 1 mil	.031"	.022"
36"	< 1 mil	.030"	.032"
42"	< 1 mil	.030"	.031"
48"	< 1 mil	.030"	.031"
54"	< 1 mil	.029"	.030"
60"	< 1 mil	.029"	.029"
66"	< 1 mil	.025"	.028"
72"	< 1 mil	.022"	.025"
78"	< 1 mil	.020"	.022"
84"	< 1 mil	.015"	.017"
90"	< 1 mil	.012"	.014"
96"	< 1 mil	.009"	.009"
102"	< 1 mil	.006"	.009"
108"	< 1 mil	.004"	.006"
114"	< 1 mil	.002"	.005"
Return End	< 1 mil	.002"	.004"
TOTAL		.453"	.476"
AVERAGE	÷ 21	.021"	.023"


 Inspector

 11-19-02
 Date

- 5.15 Torque the bolts to 200 ft/lbs, starting from the center using a stagger pattern.

R. L. Hill
Technician(s)

11/19/02
Date

- 5.16 Measure and record the parting plane gap at 6" intervals starting at the lead end on both sides of the magnet.

Inches from the Lead End	Limit	Left Side	Right Side
0"	< 1 mil	.000"	.000"
6"	< 1 mil	.001"	.001"
12"	< 1 mil	.004"	.002"
18"	< 1 mil	.006"	.004"
24"	< 1 mil	.010"	.007"
30"	< 1 mil	.012"	.010"
36"	< 1 mil	.015"	.012"
42"	< 1 mil	.015"	.015"
48"	< 1 mil	.016"	.020"
54"	< 1 mil	.017"	.022"
60"	< 1 mil	.016"	.026"
66"	< 1 mil	.014"	.030"
72"	< 1 mil	.012"	.025"
78"	< 1 mil	.010"	.022"
84"	< 1 mil	.008"	.015"
90"	< 1 mil	.006"	.009"
96"	< 1 mil	.004"	.005"
102"	< 1 mil	.003"	.003"
108"	< 1 mil	.001"	.002"
114"	< 1 mil	.000"	.000"
Return End	< 1 mil	.000	.000
TOTAL		.168	.228
AVERAGE	÷ 21	.008	.010

[Signature]
Inspector

11-19-02
Date

- 5.17 Torque the bolts to 250 ft/lbs, starting from the center using a stagger pattern.

Note: Re-torque bolts as necessary to ensure bolts have stabilized at specified torque.

pd Miller
Technician(s)

11/18/02
Date

- 5.18 Measure and record the parting plane gap at 6" intervals starting at the lead end on both sides of the magnet.

Inches from the Lead End	Limit	Left Side	Right Side
0"	< 1 mil	.000"	.000"
6"	< 1 mil	.000"	.000"
12"	< 1 mil	.000"	.000"
18"	< 1 mil	.000"	.000"
24"	< 1 mil	.001"	.001"
30"	< 1 mil	.003"	.002"
36"	< 1 mil	.004"	.004"
42"	< 1 mil	.005"	.007"
48"	< 1 mil	.004"	.010"
54"	< 1 mil	.004"	.012"
60"	< 1 mil	.003"	.012"
66"	< 1 mil	.002"	.010"
72"	< 1 mil	.002"	.009"
78"	< 1 mil	.001"	.007"
84"	< 1 mil	.001"	.006"
90"	< 1 mil	.001"	.004"
96"	< 1 mil	.000"	.003"
102"	< 1 mil	.000"	.001"
108"	< 1 mil	.000"	.000"
114"	< 1 mil	.000"	.000"
Return End	< 1 mil	.000	.000
TOTAL		.031	.088
AVERAGE	÷ 21	.001	.004

[Signature]
Inspector

11-18-02
Date

- 5.19 Torque the bolts to 350 ft/lbs, starting from the center using a stagger pattern.

Note: Re-torque bolts as necessary to ensure bolts have stabilized at specified torque.

Bob Wilf
Technician(s)

11/19/02
Date

- 5.20 Measure and record the parting plane gap at 6" intervals starting at the lead end on both sides of the magnet.

Inches from the Lead End	Limit	Left Side	Right Side
0"	< 1 mil	< .001"	< .001"
6"	< 1 mil		
12"	< 1 mil		
18"	< 1 mil		
24"	< 1 mil		
30"	< 1 mil		
36"	< 1 mil		
42"	< 1 mil		
48"	< 1 mil		
54"	< 1 mil		
60"	< 1 mil		
66"	< 1 mil		
72"	< 1 mil		
78"	< 1 mil		
84"	< 1 mil		
90"	< 1 mil		
96"	< 1 mil		
102"	< 1 mil		
108"	< 1 mil		
114"	< 1 mil		
Return End	< 1 mil		
TOTAL			
AVERAGE	÷ 21	< .001"	< .001"

Note: The Parting Plane average gap is not to exceed 0.005" per side and it is not to exceed 0.010" in any one location.

[Signature]
Inspector

11-19-02
Date

5.21 Apply label/spray paint in 1" high characters to the top magnet core:

Bolts torqued to 350 ft/lbs.

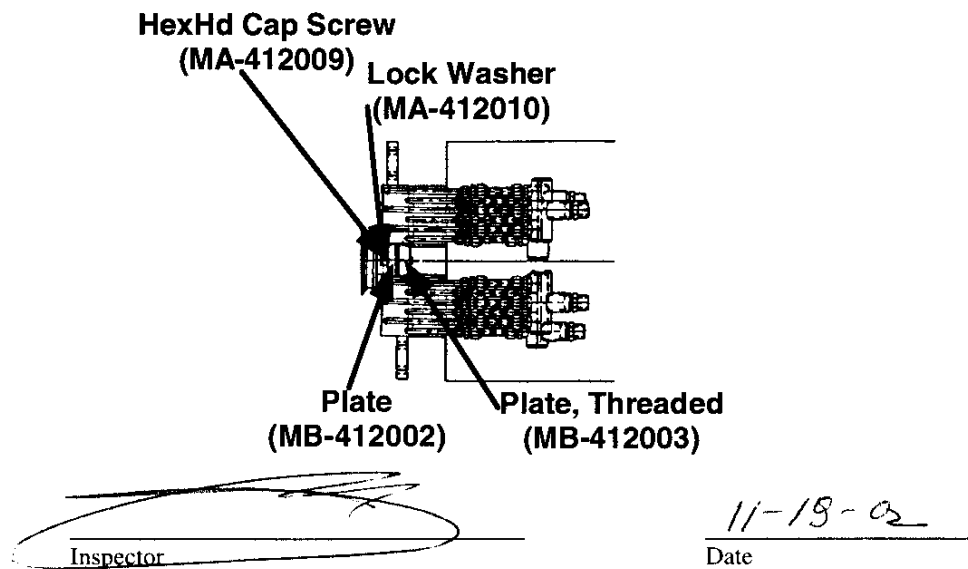
[Signature]
Technician(s)

11/19/02
Date

6.0 Electrical Inspection

- 6.1 Remove from the Upper Coil Assembly Connecting Plate and Lower Coil Assembly Connecting Plate the Plate (MB-412002), Plate Threaded (MB-412003), Hex Socket Head Cap Screw (MA-41200) and Lock Washer (MA-412010). b

Note: Insulate the Upper Coil Connecting Plate from the Lower Coil Connecting Plate using 0.005" kapton non-adhesive film.

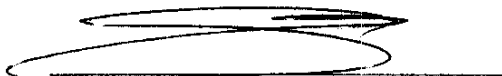


6.2 Perform an electrical check of the Upper and Lower Coil and record results below.

Note: Insulate the Upper Coil Connecting Plate from the Lower Coil Connecting Plate using 0.005" kapton non-adhesive film before performing the Electrical Inspection.

Upper Coil	Equipment Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Coil Resistance	32- 1005 1515	14.1 to 17.1	15.19 mΩ	✓		
LS @ 1 KHz	84618	For Reference Only	934 μH	—		
Q @ 1 KHz		For Reference Only	1.4			
LS @ 100 Hz		For Reference Only	2.42 mH	—		
Q @ 100 Hz		For Reference Only	1.5			
100 V Ring	P62030			✓		
Hi Pot Coil to Core 1500 V	AR0503	< 5 μA	.1 μA	✓		

Lower Coil	Equipment Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Coil Resistance	32-1515	14.1 to 17.1	15.11 mΩ			
LS @ 1 KHz	84618	For Reference Only	896 μH	—		
Q @ 1 KHz		For Reference Only	1.3			
LS @ 100 Hz		For Reference Only	2.38 mH	—		
Q @ 100 Hz		For Reference Only	1.4			
100 V Ring	P62030			✓		
Hi Pot Coil to Core 1500 V	AR0503	< 5 μA	.1 μA	✓		


Inspector

11-19-02
Date

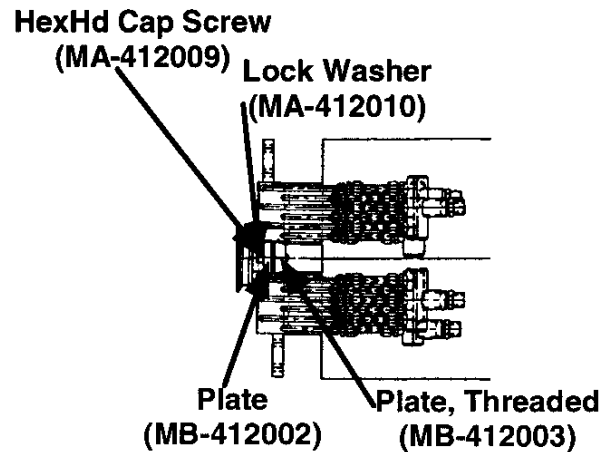
October 22, 2002

Rev. B



- 6.3 Connect the Upper Coil Assembly Connecting Plate and Lower Coil Assembly Connecting Plate together with Plate (MB-412002), Plate Threaded (MB-412003), using Hex Socket Head Cap Screw (MA-41200) and Lock Washer (MA-412010) and torque to 50 ft/lbs.

Note: Remove the 0.005" kapton non-adhesive film before tighten Connecting Plates together.



- 6.4 Perform an electrical check of the Full Magnet and record results below.

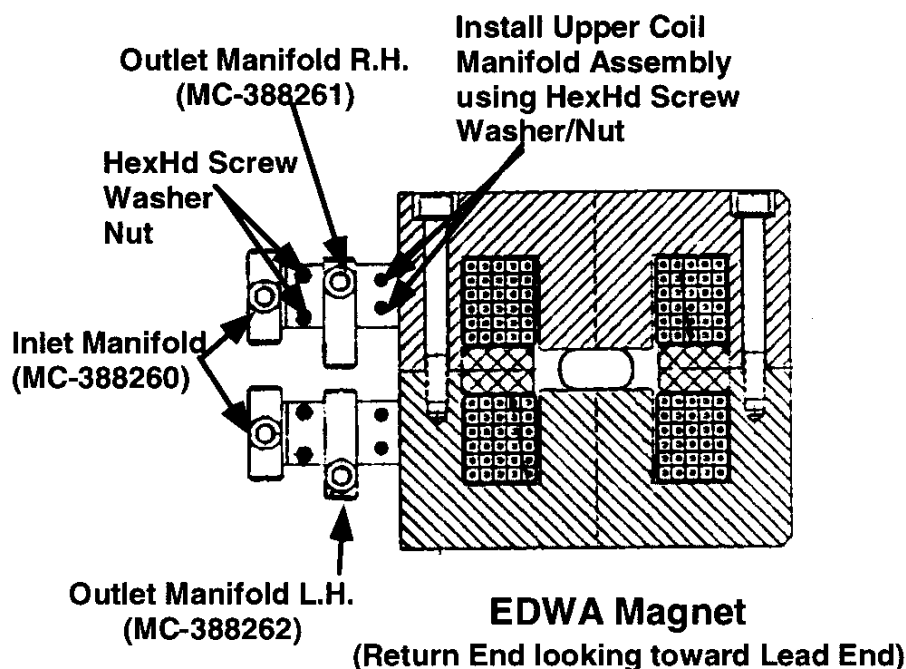
Full Magnet	Equipment Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Coil Resistance	32-1515	28.2 to 34.2	30.21 mΩ	✓		
LS @ 1 KHz		For Reference Only	1.97 mH			
Q @ 1 KHz		For Reference Only	1.2			
LS @ 100 Hz		For Reference Only	5.86 mH			
Q @ 100 Hz		For Reference Only	1.3			
100 V Ring	P62030			✓		
Hi Pot Coil to Core 1500 V	AR0503	< 5 μA	.1 mA	✓		

Inspector

 11-19-02
Date

7.0 ManifoldingCompleted ☒

- 7.1 Re-connect the Upper Coil Assembly Inlet Manifold (MC-388261) to the Manifold Holder Plate on the Upper Core using HexHd Screws (MA-412011), flat washer (MA-412012), and nuts (MA-412013), per EDWA Final Assembly Dwg (ME-388191).



Rob Hill
Technician(s)

11/19/02
Date

- X 7.2 Verify correct installation of the Upper Coil Manifold Assembly to the Upper Core.

J. S. Sanyal
Lead Person

11-19-02
Date

- 7.3 Weld the Manifold Holder Plate (MB-412138) for the Outlet Manifold L.H. and Outlet Manifold R.H. to the magnet as per EDWA Final Assembly Dwg (ME-388191).

NA
Welder(s)

Date

Rob Hill
Technician(s)

11/19/02
Date

8.0 Magnet Final Inspection

8.1 Perform a Post Manifold electrical check of the Magnet and record results below.

Electrical Test	Equipment Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
Magnet Resistance	32-1515	28.2 to 34.2	30.10 mΩ	✓		
LS @ 1 KHz	84618	Reference Test Only Not Subject to Limit Values	1.95 MH			
Q @ 1 KHz		Reference Test Only Not Subject to Limit Values	1.2			
LS @ 100 Hz		Reference Test Only Not Subject to Limit Values	5.84 MH			
Q @ 100 Hz		Reference Test Only Not Subject to Limit Values	1.3			
100 Volt Ring	P62000					
Hipot Coil to Core	AR0503	1500 V @ < 5 μA	1 μA	✓		

D. G. Du
Inspector

11/19/02
Date

8.2 Leak check the joints. Perform a 30-PSI pressure test using house air and snoop (Fermi stock 1070-2200) on the manifold joints prior to performing the flow tests.

Coil Location	Pass	Fail
Upper Coil	✓	
Lower Coil	✓	

- 8.3 Perform a Flow Check at a ΔP of 60 PSI and 100 PSI and record the results below. Refer to the Mechanical (Flow) Inspection (5520-ES-318968).

Upper Coil Assembly

Flow Test	Flow Cart Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
ΔP 60 PSI	WFE# 4	≥ 1.5 GPM	2.40	✓		
ΔP 100 PSI		≥ 2.0 GPM	3.21	✓		

Lower Coil Assembly

Flow Test	Flow Cart Serial Number	Limit	Actual Measurement	Pass	Fail	Out of Tolerance
ΔP 60 PSI	WFE# 4	≥ 1.5 GPM	2.42	✓		
ΔP 100 PSI		≥ 2.0 GPM	3.23	✓		

- 8.4 Perform a hydrostatic check of the joint at 500 PSI for 30 minutes.

Coil Location	Pass	Fail
Upper Coil	✓	
Lower Coil	✓	

- 8.5 Purge the Upper Half Magnet water passage using house air, until no water is present in the manifold. ☒

- 8.6 Purge the Lower Half Magnet water passage using house air, until no water is present in the manifold. ☒

D. G. Du
Inspector

11/20/02
Date

October 22, 2002

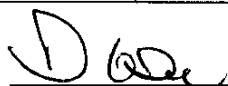
Rev. B

Completed



- 8.7 Perform a Vacuum Leak Check of the Beam Tube Assembly and record results below.

PART NO.		SCALE UNITS BEFORE HELIUM PROBE	SCALE UNITS WHILE ENCLOSURE FLOODING	DETERMINATION OF MINIMUM DETECTABLE LEAK				
DATE TIME	OPERATOR'S LAST NAME			MDS ÷ ((Response - Bckgnd) ÷ Leak Value) = MDL				
11/20/02	ADU	2081	2061	2	38.5	2081	3.91x10 ⁸	4.6x10 ⁻¹⁰



Inspector



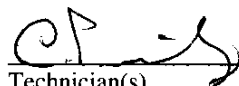
Date

- 8.8 Prime all areas of the magnet not previously painted with Paint Primer (MA-388153).

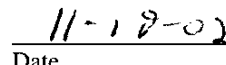
Note: Do not prime the survey holes, ground lug hole, etc.

- 8.9 Paint all primed areas of the magnet using Paint FNAL Blue (MA-351184).

Note: Do not paint the survey holes, ground lug hole, etc.

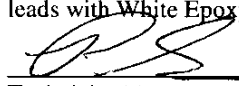


Technician(s)

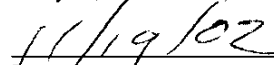


Date

- 8.10 Wrap all tubing at the lead end with Fiberglass Tape (MA-116511). Paint the wrapped leads with White Epoxy Paint (MA-274444) and Epoxy Paint Catalyst (MA-274445).

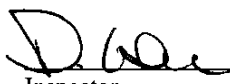


Technician(s)

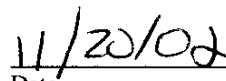


Date

- X 8.11 Verify the magnet is properly painted and stenciled.




Inspector



Date

- 8.12 Affix the completed Generic Magnet Identification Labels (MA-318490) (Qty. 2) on the magnet. Place one label on the Lead End, Non-Manifold Side, approximately 6" from magnet end. Place the other label on the magnet on the Return End, Manifold Side, approximately 6" from magnet end. Affix a completed Generic Magnet Identification Label (MA-318490) to this page or complete the facsimile below.

 Fermi National Accelerator Laboratory Technical Division						
Booster 5.3 - 2 -120 EDWA Dipole Magnet						
Serial No:	EDWA004-1	Drawing No:	ME-388191	Magnet Weight:	9,500 Lbs	
	DC Resistance:	LS@1kHz:	Q@1kHz:	LS@100Hz:	Q@100Hz:	Hipot To Gnd @ 1500VDC
Upper Coil:	15.19 mΩ	934 μH	1.4	2.42 mH	1.5	.1 μA
Lower Coil:	15.11 mΩ	896 μH	1.3	2.38 mH	1.4	.1 μA
Full Magnet:	30.1 mΩ	1.95 mH	1.2	5.84 mH	1.3	.1 μA
	Flow Low 60 ΔPSI:	Flow High 100 ΔPSI:		Hydro Upper and Lower Coil @:		
Upper Coil:	2.4 GPM	3.21 GPM		500 PSIG for: 30 Mi		
Lower Coil:	2.42 GPM	3.23 GPM				
Previous Serial No(s): EDWA004-0						
Remarks: This set of electrical measurements were taken with the Beam Tube installed.						
Date Completed: 11/20/2002						

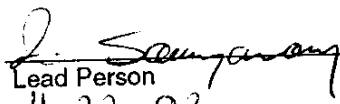
Partially Completed
Generic Magnet Identification Label (MA-318490)


Inspector

11-20-02
Date

8.13

Update DSR Keywords
Location,
Location Verified Date
Status
Make entry regarding work
performed.


Lead Person
11-22-02
Date

9.0 Production Complete

- 9.1 Process Engineering verify that the Booster EDWA Dipole Dis-Assembly/Re-Assembly with Beam Tube Traveler (5520-TR-333660) is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off. Ensure that all Discrepancy Reports, Nonconformance Reports, Repair/Rework Forms, Deviation Index and dispositions have been reviewed by the Responsible Authority for conformance before being approved.

Comments:

Survey/shipping delay


Process Engineering Designee

2/12/03
Date

ADDITIONAL PARTS REQUEST

**ADDITIONAL PARTS REQUEST FORM SHALL BE USED TO ACCESS ALL ITEMS FROM INVENTORY
WITH THE EXCEPTION OF PARTS KITS.**

THIS FORM MUST BE SIGNED BY AN ACQUISITIONER BEFORE BRINGING TO THE STOCKROOM

MAGNET OR COIL # EDWA003-0 4 004-0REQUESTED BY Bob JensenDATE REQUESTED 9/26/02DELIVER TO Bob Jensen / IB #2BUDGET CODE FOINEED BY DATE 10/2/02

JOB TICKET # _____

MMR # _____

MACHINE SHOP REQ. # _____

PO # _____

PURCHASE RELEASE # _____

OTHER _____

PARTS STATUS (CHECK ONE)☐ DEFECTIVE PARTS ISSUED☐ PARTS SCRAPPED☐ A/R ITEMS☐ DEFECTIVE ASSEMBLY☒ MISSING FROM KIT ALREADY ISSUED☒ INDIVIDUAL PARTS☐ CONSUMABLES☐ PARTS LOSTACQUISITIONER SIGNATURE [Signature]ID# 4698 DATE 11/13/02**PLEASE INDICATE REVISION REQUIRED**

LOCATION PART # REV QTY UOM DESCRIPTION RF # SIR #

	412004	A	2	Each	Beam Table Assy	792.42	
7B4-BIN	412028	-	4	EA	LOCATING PIN	77950	

STOCKROOM SIGNATURE [Signature]ID# 12691 DATE 11/14/02

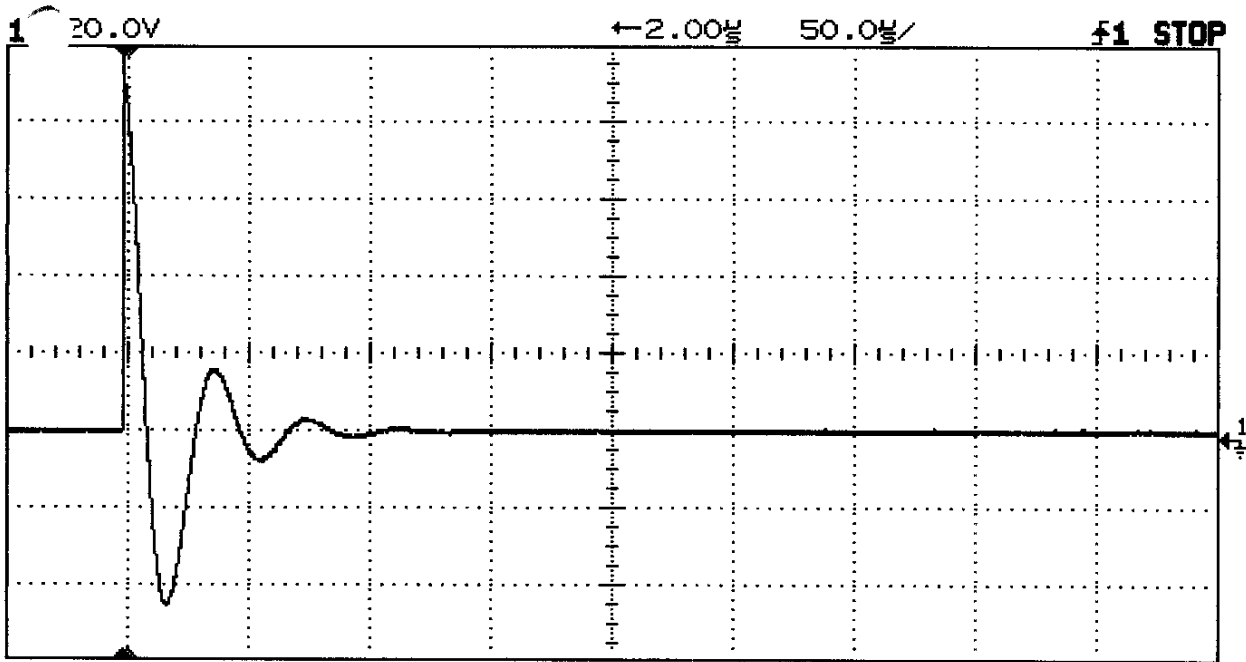
PARTS DELETED FROM DATABASE _____

ID# _____ DATE _____

A COPY OF THIS FORM IS TO BE INCLUDED IN WITH THE TRAVELER

PARTS RECEIVED BY Bob JensenID# 0315 DATE 11/14/02

08:36:27 Tue Nov 19, 2002



	State	Volts/Div	Position	Cplg	BW Lim	Inv	Probe
Chan 1	On	20.00 V	-21.88 V	AC	On	Off	10:1
Chan 2	Off	50.00mV	0.000 V	DC	Off	Off	1:1

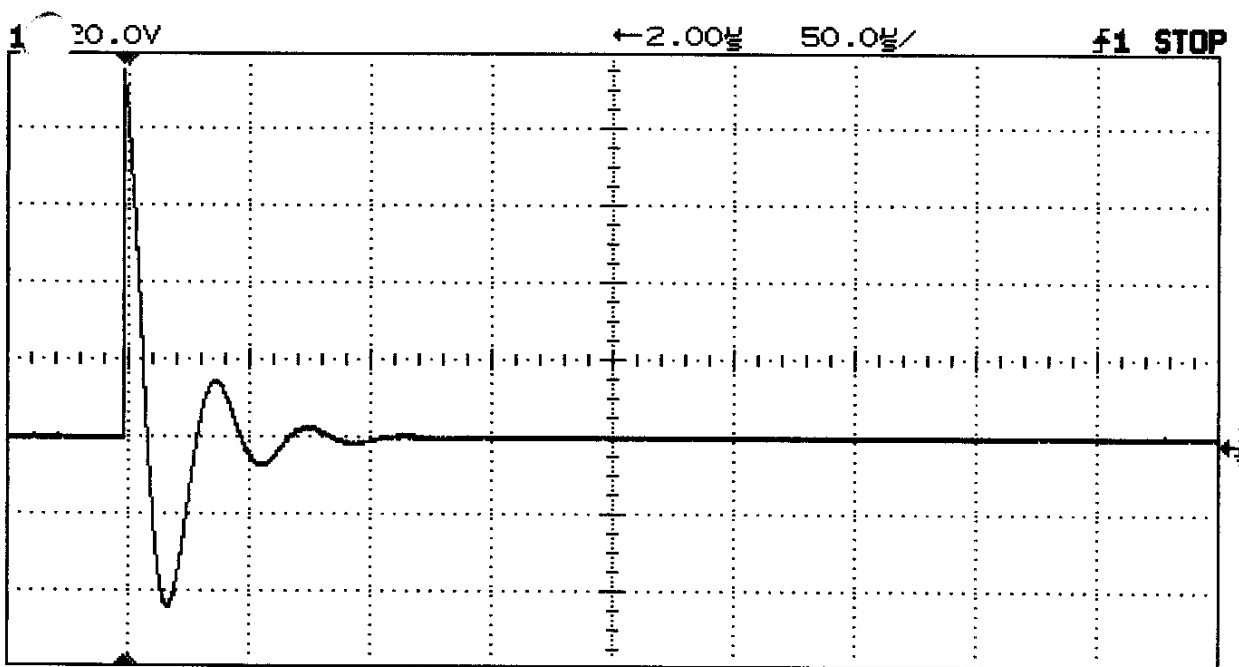
	Mode	Main Time/Div	Main Delay	Time Ref	Delayed Time/Div	Delayed Delay
Horizontal	Normal	50.00us/	2.000us	Left	-----	-----

Trigger Mode	Source	Level	Holdoff	Slope	Couplg	Reject	NoiseRej
Normal	Ch 1	4.375 V	200.0ns	Pos	DC	Off	Off

Display Mode: Normal

Traveler	333661
Step #	6.2
Magnet Serial Number	EDWA 004-1 LOWER
Technician	J. SZAR
Page Count	1 of 1

08:35:20 Tue Nov 19, 2002



	State	Volts/Div	Position	Cplg	BW Lim	Inv	Probe
Chan 1	On	20.00 V	-21.88 V	AC	On	Off	10:1
Chan 2	Off	50.00mV	0.000 V	DC	Off	Off	1:1

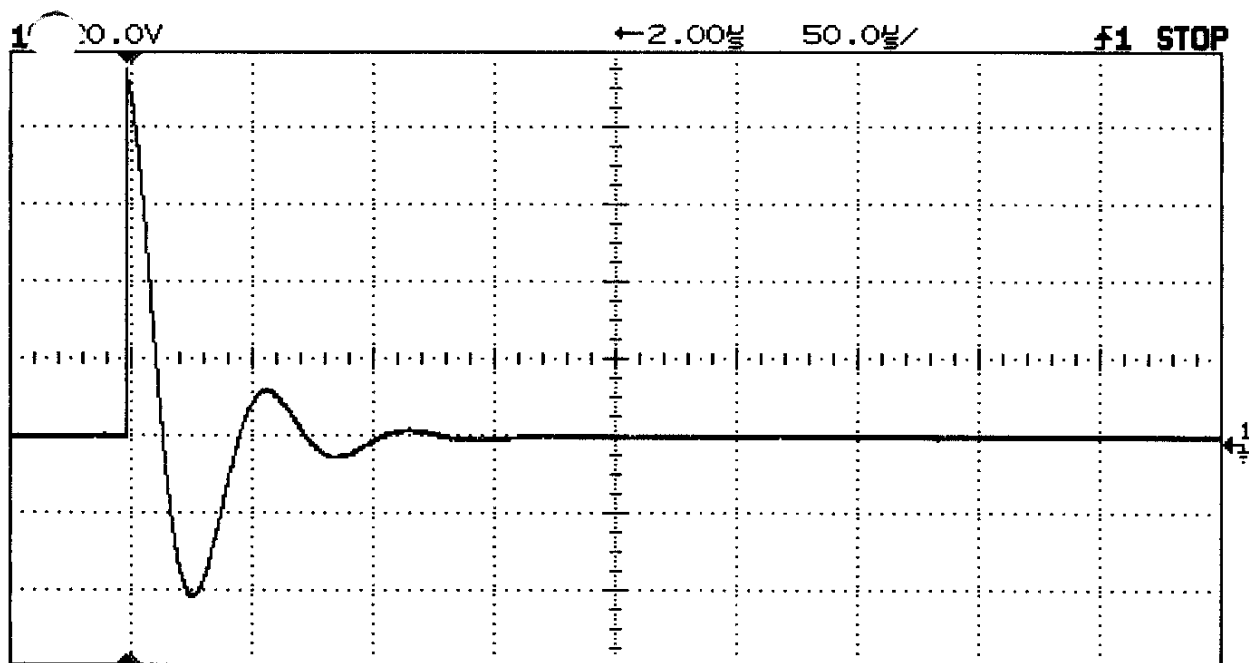
	Mode	Main Time/Div	Main Delay	Time Ref	Delayed Time/Div	Delayed Delay
Horizontal	Normal	50.00us/	2.000us	Left	-----	-----

Trigger Mode	Source	Level	Holdoff	Slope	Couplg	Reject	NoiseRej
Normal	Ch 1	4.375 V	200.0ns	Pos	DC	Off	Off

Display Mode: Normal

Traveler	333 661
Step #	6.2
Magnet Serial Number	EDWA004-1 UPPER
Technician	3-S2AL
Page Count	1 of 1

08:33:42 Tue Nov 19, 2002



	State	Volts/Div	Position	Cplg	BW Lim	Inv	Probe
Chan 1	On	20.00 V	-21.88 V	AC	On	Off	10:1
Chan 2	Off	50.00mV	0.000 V	DC	Off	Off	1:1

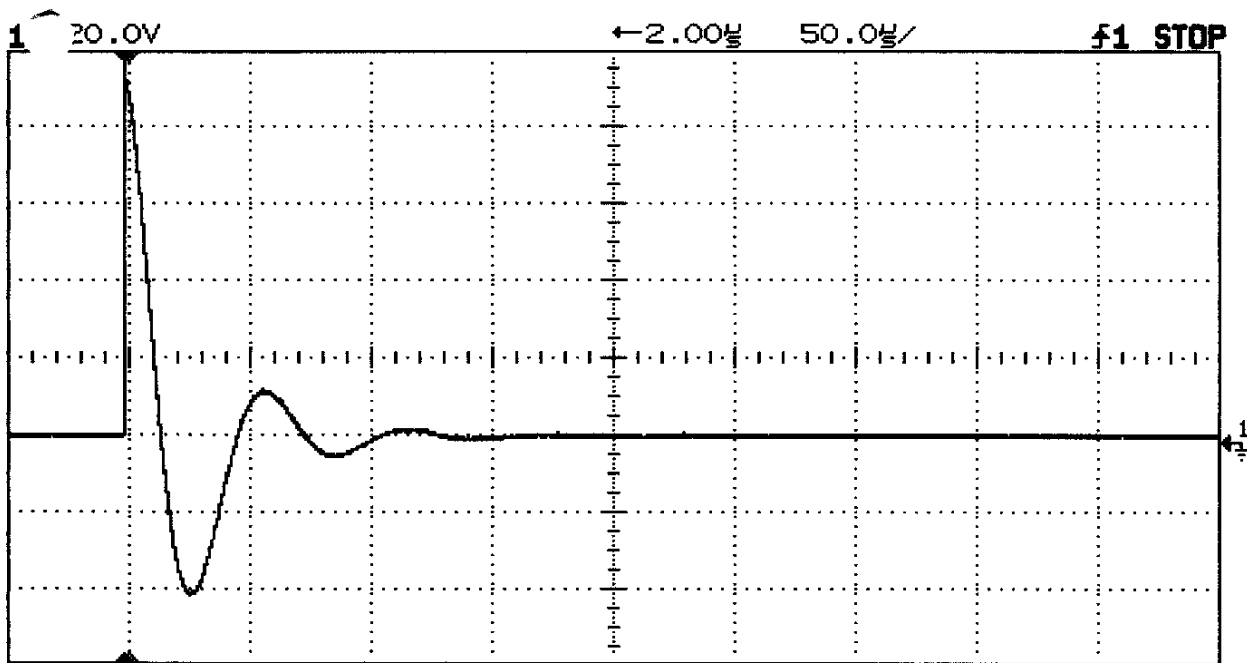
	Mode	Main Time/Div	Main Delay	Time Ref	Delayed Time/Div	Delayed Delay
Horizontal	Normal	50.00us/	2.000us	Left	-----	-----

Trigger Mode	Source	Level	Holdoff	Slope	Couplg	Reject	NoiseRej
Normal	Ch 1	4.375 V	200.0ns	Pos	DC	Off	Off

Display Mode: Normal

Traveler	333661
Step #	6.4
Magnet Serial Number	EDWAD004-1
Technician	J. SZAL
Page Count	1 of 1

08:38:43 Tue Nov 19, 2002



	State	Volts/Div	Position	Cplg	BW Lim	Inv	Probe
Chan 1	On	20.00 V	-21.88 V	AC	On	Off	10:1
Chan 2	Off	50.00mV	0.000 V	DC	Off	Off	1:1

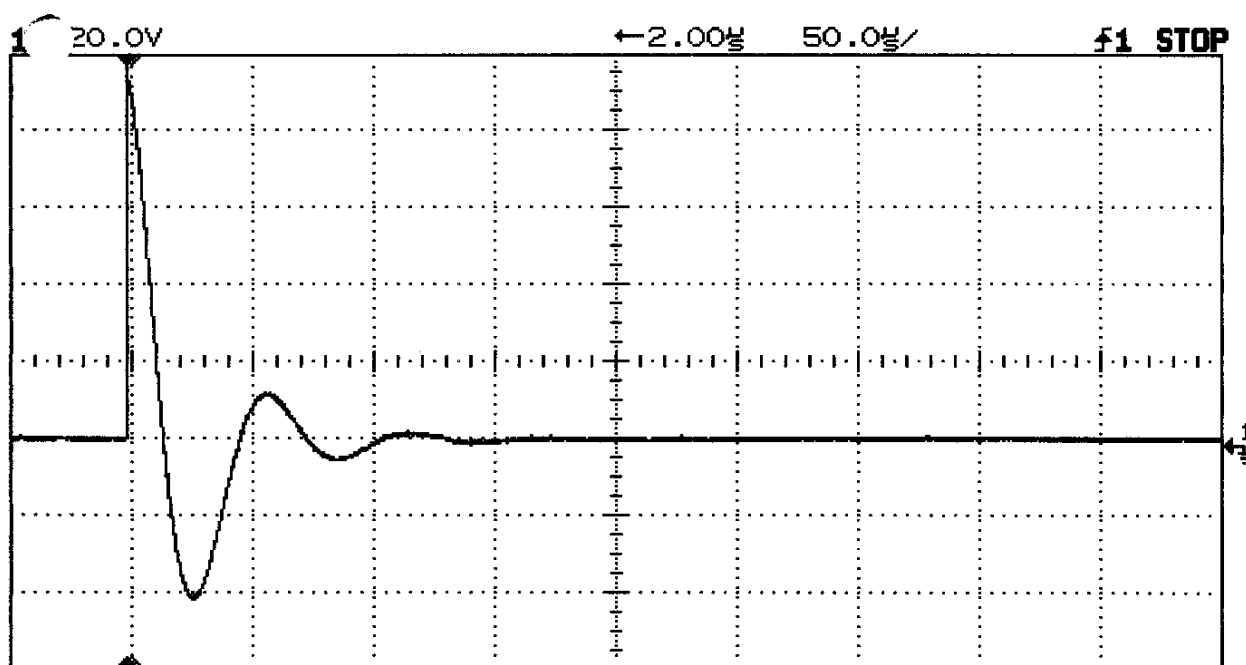
	Mode	Main Time/Div	Main Delay	Time Ref	Delayed Time/Div	Delayed Delay
Horizontal	Normal	50.00us/	2.000us	Left	-----	-----

Trigger Mode	Source	Level	Holdoff	Slope	Couplg	Reject	NoiseRej
Normal	Ch 1	4.375 V	200.0ns	Pos	DC	Off	Off

Display Mode: Normal

Traveler	333661
Step #	8.1
Magnet Serial Number	EDWA004-1
Technician	J. SZAL
Page Count	1 of 1

14:57:28 Tue Nov 19, 2002



	State	Volts/Div	Position	Cplg	BW Lim	Inv	Probe
Chan 1	On	20.00 V	-21.88 V	AC	On	Off	10:1
Chan 2	Off	50.00mV	0.000 V	DC	Off	Off	1:1

	Mode	Main Time/Div	Main Delay	Time Ref	Delayed Time/Div	Delayed Delay
Horizontal	Normal	50.00us/	2.000us	Left	-----	-----

Trigger Mode	Source	Level	Holdoff	Slope	Couplg	Reject	NoiseRej
Normal	Ch 1	4.375 V	200.0ns	Pos	DC	Off	Off

Display Mode: Normal

Traveler	333661
Step #	8.1
Magnet Serial Number	EDWACEN-1
Technician	D. Goe
Page Count	1 of 1

Traveler Title:

Booster 5.3-2-120 EDWA Dipole Dis-Assembly/Re-
Assembly w/Beam Tube

Specification No:

5520-TR-333661

Revision:

B

DR No:

EDW-0017

Step No:

5.5

Drawing No:

ME-388191

Routing Form No:

Serial No:

EDWA004-1

Discrepancy Description:

Step instructs to, Install Beam Tube Assembly (MD-412004). Ensure the Locating Pins are properly installed into the pins holes in the Lower Half Core.

Visual inspection discovered that the lead end locating pin (MA-412028) does not fit properly into the locating hole in the lower half core (ME-388243).

NOV 22 2002

TD-EPD PRODUCTS ENGINEERING

Originator:

Dennis Gaw

Date:

11/21/02

Cause of Nonconformance:

Pin weld is too big to fit the chamfer in the core pole..

Responsible Authority:

Sasha Makarov

Date:

11/21/02

Disposition:

Grind off excess of weld.
All of the affected beamtubes have had the excess weld removed and have passed helium leak testing.
(Dennis Gaw 11-21-02).

Responsible Authority:

Sasha Makarov

Date:

11/21/02

Corrective Action to Prevent Recurrence:

None

Responsible Authority:

Sasha Makarov

Date:

11/21/02

Corrective Action/Disposition Verified By:

Dennis Gaw

Date:

11/21/02

Will Configuration be affected?:

☐ YES

☒ NO

Identified problem area:

☐ Material

☐ Manpower

☒ Method

☐ Machine

☐ Measurement

Reviewed By:

Bob Jensen

Date:

11/21/02

TD/Engineering & Fabrication Production Readiness Check-Off List

Project Name:	Booster EDW A DIPOLE WINDEN COIC									
Budget Code	FOI			Project Code	0166					
Project Contact:	S. MAKAREN			Phone	4734					
QTY:	30			Date Req'd:						
Magnet Designator	EDWA			Magnet Serial No's:	CW 001 - 030 MAG 001 - 005					
DSR	Completed Process Engineering			NO				Sign-Off	Date	
Schedule: Do we need one?	YES	X		NO				Process Engineering		
DWGS:	Main Assy	ME-388191								
Tooling	Existing	YES			NO					
	Provided by Requestor	YES			NO					
	TD/E&F Develop	YES		X	NO				Bob Jones	2/7/0
Product	Existing	YES			NO					
	Provided by Requestor	YES			NO					
	TD/E&F Develop	YES		X	NO				Bob Jones	2/7/0
Parts Ordered/Received?	YES		NO					Process Engineering		
Tooling: Is it available for Production?	YES	X	NO					Bob Jones		2/7/0
Travelers:	YES	X	NO		Traveler No. # 333653			Bob Jones		2/7/0
Parts Kits:	YES	X	NO					Bob Jones		2/7/0
Production Package DWG Book	YES		X	NO				Bob Jones		2/7/0
OK to Start Production							John Carson/designee		2/11/0	

TD/Engineering & Fabrication Production Readiness Check-Off List

Project Name:		BOOSTER EDWA DEFOLE WINDING COIL									
Budget Code		FOI 1111				Project Code		0166			
Project Contact:		S. Makarov J. Lackey				Phone					
QTY:		30				Date Req'd:					
Magnet Designator		EDWA				Magnet Serial No's:		CW001 - 030 001 - 005			
		S/C		Conv		Mag Series List					
DSR		Completed Process Engineering				NOT REQ'D		Sign-Off		Date	
Schedule: <small>Do we need one?</small>		YES		NO				Process Engineering			
DWGS:		Main Assy									
Tooling		Existing		YES		NO		Bob Jusz		1/31/0	
		Provided by Requestor		YES		NO					
		TD/E&F Develop		YES		NO		Bob Jusz		1/31/0	
Product		Existing		YES		NO					
		Provided by Requestor		YES		NO					
		TD/E&F Develop		YES		NO		Bob Jusz		1/31/0	
Parts <small>Ordered/Received?</small>		YES		NO				Process Engineering			
Tooling: <small>Is it available for Production?</small>		YES		NO				Bob Jusz		1/31/0	
Travelers:		YES		NO		Traveler No. # 333653		Process Engineering			
Parts Kits:		YES		NO				Process Engineering			
Production Package <small>DWG Book</small>		YES		NO				Process Engineering			
OK to Start Production								John Carson/designee			

TD/Engineering & Fabrication Production Readiness Check-Off List

Project Name:	BOOSTER EDWA DEPOLG COILS/ASSI					UPPER/LOWER	
Budget Code	FOI		Project Code	0166			
Project Contact:	S. MAKAROV		Phone	X4734			
QTY:			Date Req'd:				
Magnet Designator	EDWA		Magnet Serial No's:	001-005 UC-001/005 LC-001/005			
			S/C	Conv	Mag Series List		
DSR	Completed Process Engineering		N/A			Sign-Off	Date
Schedule: <small>Do we need one?</small>	YES	X	NO			Bob Jones Process Engineering	3/12/00
DWGS:	Main Assy	WE-388193 DE-388194					
Tooling	Existing	YES	NO				
	Provided by Requestor	YES	NO				
	TD/E&F Develop	YES	X	NO	Bob Jones		3/12/00
Product	Existing	YES	NO				
	Provided by Requestor	YES	NO				
	TD/E&F Develop	YES	X	NO	Bob Jones		3/12/00
Parts <small>Ordered/Received?</small>	YES	NO					
	Process Engineering						
Tooling: <small>Is it available for Production?</small>	YES	X	NO				
Travelers:	YES	X	NO	Traveler No. # TR-333654 TR-333655		Bob Jones Process Engineering	3/12/00
Parts Kits:	YES	X	NO			Bob Jones Process Engineering	3/12/00
Production Package <small>DWG Book</small>	YES	X	NO			Bob Jones Process Engineering	3/12/00
OK to Start Production						John Carson/Design	3/12/00

TD/Engineering & Fabrication
Production Readiness Check-Off List

Project Name:	BOOSTER EDWA DIPOLE COIL IMPREGNATION/CURING										
Budget Code	FOI			Project Code			0166				
Project Contact:	S. MAKAREN			Phone			X4734				
QTY:	10 coils			Date Req'd:							
Magnet Designator	EDWA			Magnet Serial No's:			001-005				
				S/C			Conv		Mag Series List		
DSR	Completed Process Engineering			N/A			Sign-Off			Date	
Schedule: Do we need one?	YES		X		NO		Bob Jusz			3/22/0	
DWGS:	Main Assy		388191								
Tooling	Existing		YES		NO						
	Provided by Requestor		YES		NO						
	TD/E&F Develop		YES		X		NO		Bob Jusz 3/22/0		
Product	Existing		YES		NO						
	Provided by Requestor		YES		NO						
	TD/E&F Develop		YES		X		NO		Bob Jusz 3/22/0		
Parts Ordered/Received?	YES		X		NO		Bob Jusz 3/22/0				
							Process Engineering				
Tooling: Is it available for Production?	YES		X		NO		Bob Jusz 3/22/0				
							388200				
Travelers:	YES		X		NO		Traveler No. #		333658		
									Bob Jusz 3/22/0		
Parts Kits:	YES		X		NO		Bob Jusz 3/22/0				
							Process Engineering				
Production Package DWG Book	YES		X		NO		Bob Jusz 3/22/0				
							Process Engineering				
OK to Start Production							John Carson/designee 3/25/0				

A "ring test" measures some properties of a subject, usually a coil, in or out of a magnet. Most importantly it identifies internal turn-to-turn shorts, as opposed to the coil to ground shorts identified with a hi-pot (high potential) test. The test consists of connecting the coil to a charged capacitor to form an LRC circuit and observing the decaying oscillations that result. The component values can be calculated from measured parameters of the waveform. Generally gross variations from the standard waveform are apparent with a turn-to-turn short.

This document specifies a general procedure. The connections to the test subject and the test voltage must be defined when the test is called for in a specification. The appropriate scales on the oscilloscope must be determined for each class of subjects and a reference trace established.

EQUIPMENT


Test electronics, such as Fermilab Magnet Coil Ringing Tester EC-46158.

Analog oscilloscope with camera, digitizing oscilloscope with printer or camera, or other waveform capturing device.

Cables.

PROCEDURE

1. Secure the area around the coil and test equipment to ensure that no personnel will come in contact with the exposed conductors.
2. With the test electronics switched off, connect the cables as shown in Figure 1.
3. Set the test voltage as called for in the subject specification.
4. Set the oscilloscope or other waveform capturing system to the appropriate voltage scale and sweep time.
5. Turn on the test electronics.
6. Adjust the trigger level on the oscilloscope, if necessary, so that it triggers at the 60 Hz rate provided by the test electronics.
7. Record the waveform with camera, printer, or on computer disk.
8. Switch off the tester electronics.
9. Short the test subject to ground to ensure that no stored charge remains.
10. Assess the technical quality of the waveform recording. Repeat the measurement if necessary.

UNLESS OTHERWISE SPECIFIED			ORIGINATOR	D. HARDING	7/13
.XX	.XXX	AMPERES	DRAWN	T. SKWERES	7/14
+	+	+	CHECKED	<i>[Signature]</i>	7/14
1. SHOW ALL SHARP EDGES ON MAX.			APPROVED	<i>[Signature]</i>	7/14
2. DO NOT SCALE DRAWING.			USED ON	N/A	
3. DIMENSIONS BASED UPON LAST V.I.S. BY-1000			MATERIAL	N/A	
4. MAX. ALL MACH. SURFACES					
 FERMI NATIONAL ACCELERATOR LABORATORY UNITED STATES DEPARTMENT OF ENERGY					
RING TEST SPECIFICATION					
SCALE	FILMED	DRAWING NUMBER		SHEET	
N/A		5520-ES-318052		1-2	
CREATED WITH I-DEAS V				USER NAME: SKWERES	

11. Scan the recorded waveform for gross abnormalities. The inspection report shall include the subject identification (type and serial number), the equipment identification (type and serial number), the waveform (photograph or printout), the date, the time, the inspector's name, and the inspector's assessment of the test.

12. Disconnect the test leads. Store all the test equipment neatly in it's designated spot.

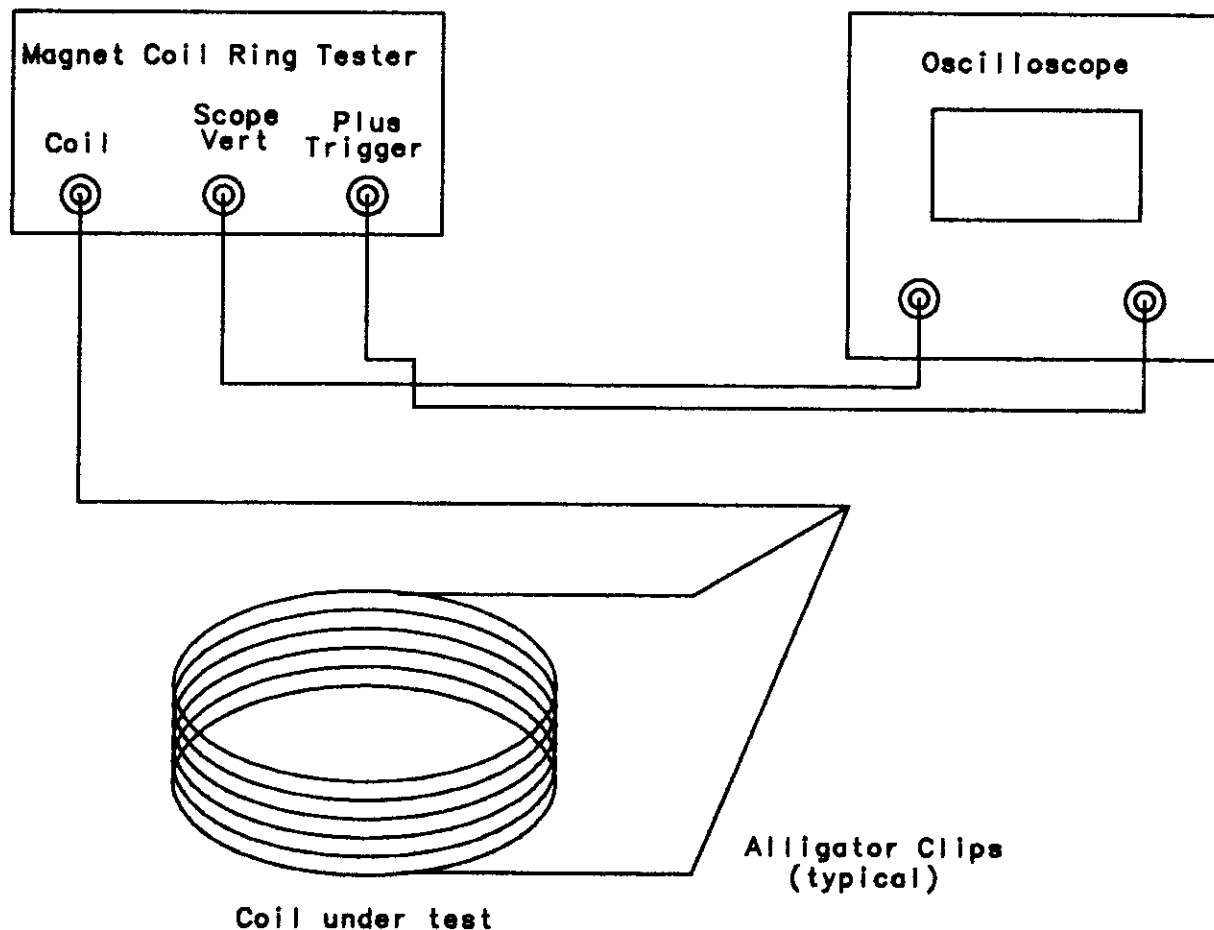


Figure 1
Cable Connection

UNLESS OTHERWISE SPECIFIED			ORIGINATOR	D. HARDING	7/13
.XX	.XXX	ANGLES	DRAWN	T. SKWERES	7/14
+	+	+	CHECKED	<i>David Harding</i>	7/14
1. BREAK ALL SHARP EDGES TO MAX.			APPROVED	<i>David Harding</i>	7/14
2. DO NOT SCALE DRAWING.			USED ON	N/A	
3. DIMENSIONS BASED UPON ASST Y14.84-1000			MATERIAL	N/A	
4. MAX. ALL MACH. SURFACES					
FERMI NATIONAL ACCELERATOR LABORATORY UNITED STATES DEPARTMENT OF ENERGY					
RING TEST SPECIFICATION					
SCALE	FILED	DRAWING NUMBER		SHEET	
N/A		5520-ES-318052		2-2	
CREATED WITH I-DEAS V				USER NAME: SKWERES	